# OBJECT LESSONS FOR RURAL SCHOOLS

## SENIOR

VINCENT T. MURCHÉ

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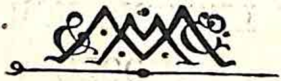

84/316

# THE TEACHER'S MANUAL

OF

# OBJECT LESSONS

FOR

# RURAL SCHOOLS

84/572

BY

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ELEMENTARY SCIENCE AND GEOGRAPHY,'
'RURAL READERS,' ETC.

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## FOR SENIOR CLASSES

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# PREFACE

THESE Manuals and the Reading Books which accompany them have been prepared as the outcome of the **"Circular to Managers and Teachers of Rural Elementary Schools,"** which was issued by the Board of Education in April last.

The Author, **himself an old rural teacher,** has endeavoured to cover as much ground as possible in meeting the requirements of that Circular, and of the schemes set forth in the Revised Instructions to H.M. Inspectors. But it should be distinctly borne in mind that **these books are not intended to form a rigid cast-iron scheme of lessons,** to be blindly followed by every teacher into whose hands they may fall. They are rather to be considered as **a store-house from which the teacher may draw,** to suit his own special conditions; and, further, the ample provision of subjects in each volume will enable him for years to construct scheme after scheme, all of them dealing with **just those subjects which will appeal to country children.**

The great aim of the teaching throughout has been to awaken in the children **the spirit and habit of observation and inquiry,** and thus to foster in them the **love of country life,** and the only true way to do this is to follow the excellent and wise recommendation of the Circular referred to above, **in taking them for rambles** wherever possible, and giving them **lessons on the spot**, which can be afterwards **recapitulated**, **amplified**, and **illustrated** in school by means of **pictures**, **drawings**, and **specimens**.

It is only those who know what it means to carry on a country school (if not single handed, at least with inadequate assistance) who can really sympathise with the rural teacher and his work. This the Author can fully claim to do, and in consequence the scheme has been arranged to meet as nearly as possible the conditions of the average village school.

All reference to standards has been carefully avoided, and the lessons have been arranged to suit the usual tripartite division of the school as recommended in the schemes of the Government Circular. It is confidently expected that, with the wealth of natural objects for illustration always ready to hand, the course will prove attractive both to teachers and children.

Notwithstanding the fact that the books have been written primarily to provide for the wants of the Rural School, it must not be forgotten that there are **hundreds of provincial towns in all parts of the country**, where the everyday life of young and old is more or less surrounded by rural pursuits, **where living in the town they breathe the atmosphere of the country**, where every walk takes them into the heart of the country, and where the villagers from all round come and go regularly on market-days.

In all such towns it is thought that this scheme may find hearty appreciation.

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Professor Meldola, in a Review on the earlier books of this course, offered some very excellent and sound advice to all who are engaged in this "Nature-Study"; and so strongly did his wise words of warning (in the midst of the unstinted praise he gave to the books themselves) appeal to the Author that, he asked for, and obtained, the Professor's permission to incorporate them, in the Preface of the next book, as a "finger-post" for teacher and children alike.

The following is the extract from the Review:—

"There is one little side issue to which the writer of this notice is glad of the present opportunity of calling attention. Now that the education of country children is making a serious departure in the right direction, the time seems ripe for inculcating that respect for living nature which is generally absent in the average child. Boys and girls are naturally destructive animals. The teachers in rural schools can do more than any other class of people to restrain and direct this tendency. They have to deal with children at the most impressionable period of their lives, and they have it in their power to point out exactly why wanton destruction is to be deprecated. The collecting of the common forms of animal and vegetable life for the purposes of study, *i.e.* for educational purposes, might be encouraged *judiciously*, but the ruthless destruction that accompanies the ordinary country ramble should be severely censured. If hordes of village school children are to be taken out into the country without proper restraint, the "nature-study" is apt to degenerate into a mere collecting raid with no educational value, and with serious consequences to our native fauna and flora. The teachers have it in their hands to impress upon their pupils that nothing is to be gained and everything to be lost by plucking every flower because it looks pretty, by raiding every nest because it is good sport, or by killing every insect that looks strange. If by proper tuition the child can be made to realise how infinitely more instructive and interesting is the living organism than the dead "specimen," a well-organised course of nature-study should have as distinct a moral influence, as it is intended to have an intellectual influence in moulding the character of the pupil. For this reason we should like to see in such works as those under consideration special and emphatic recommendations to teachers to repress all unscientific collecting."

R. MELDOLA.

Ed/572

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# THE CURRICULUM OF THE RURAL SCHOOL

THE following circular to managers and teachers of rural elementary schools has been issued by the Board of Education :—

BOARD OF EDUCATION, WHITEHALL,
LONDON, S.W., *April* 1900.

SIR—The Board of Education are anxious to call the attention of managers and teachers of elementary schools situated in the agricultural districts of England and Wales to the importance of making the education in the village school more consonant with the environment of the scholars than is now usually the case, and especially of encouraging the children to gain an intelligent knowledge of the common things that surround them in the country. From experience gained in various districts it is found that by a suitable arrangement and handling of the school curriculum this object can often be attained without necessarily adding any new subjects to the time-table, or demanding any undue burden or work from teachers or scholars.

The Board would deprecate the idea of giving in rural elementary schools any professional training in practical agriculture, but they think that teachers should lose no opportunity of giving their scholars **an intelligent knowledge of the surroundings of ordinary rural life** and of showing them how to **observe the processes of nature** for themselves. One of the main objects of the teacher should be to develop in every boy and girl that **habit of inquiry and research** so natural to children ; they should be encouraged to ask their own questions about the **simple phenomena of nature** which they see around them, and themselves to **search for flowers, plants, insects,** and other objects to illustrate the lessons which they have learnt with their teacher.

The Board consider it, moreover, highly desirable that the natural activities of children should be turned to useful account—that **their eyes,** for example, **should be trained to recognise plants and insects** that are **useful** or **injurious** (as the case may be) **to the agriculturist,** that **their hands should be trained to some of the practical dexterities of rural life,** and not merely to the use of pen and pencil, and that they should be taught, when circumstances permit, how to **handle the simpler tools that are used in the garden** or on the farm, before their school life is over.

The Board are of opinion that one valuable means of evoking interest in country life is to select for the object lessons of the lower standards subjects that have a connection with the daily surroundings of the children, and that these lessons should lay the foundation of a somewhat more comprehensive teaching of a similar kind in the upper standards.[1] But these object lessons must not be, as is too often the case, mere repetitions of descriptions from text-books, nor a mechanical interchange of set questions and answers between teacher and class. To be of any real use in stimulating the intelligence, the object lessons should be the practising ground for observation and inference, and **they should be constantly illustrated by simple experiments and practical work in which the children can take part, and which they can repeat for themselves at home with their own hands.** Specimens of such courses can be obtained on application to the Board of Education. These may be varied indefinitely to suit the needs of particular districts. They are meant to be typical and suggestive, and teachers, it is hoped, will frame others at their discretion. Further, these lessons are enhanced in value if they are connected with other subjects of study. The object lesson, for example, and the drawing lesson may often be associated together, and the children should be taught to draw actual objects of graduated difficulty, and not merely to work from copies. In this way they will gain a much more real knowledge of common implements, fruits, leaves, and insects than if these had been merely described by the teacher or read about in a lesson-book. Composition exercises may also be given—after the practical experiments and observations have been made—for the purpose of training the children to express in words both what they have seen and the inferences which they draw from what they have seen; and the children should be frequently required and helped to describe in their exercise books sights of familiar occurrence in the woods and in the fields. Problems in arithmetic connected with rural life may also be frequently set with advantage.

The Board of Education also attach considerable importance to work being done by the elder scholars outside the school walls, whether such work takes the form of elementary mensuration, of **making sketch plans of the playground and the district surrounding the school**, of **drawing common objects**, of **paying visits of observation to woods, lanes, ponds, farms, and other suitable places under the guidance of the teacher**, or **of the cultivation of a school garden.**

The teacher should as occasion offers take the children out of doors **for school walks at the various seasons of the year,** and **give simple lessons on the spot** about **animals in the fields and farm-yards,** about **ploughing and sowing,** about **fruit trees and forest** trees, about birds, insects, and flowers, and other objects of interest. The lessons thus learnt out of doors can be afterwards carried forward in the schoolroom by reading, composition, pictures, and drawing.

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[1] The important points to be observed in all object teaching were set out in the Official Circular (No. 369) issued on this subject on 25th June 1895, copies of which may be obtained from the Board of Education.

In this way, and in various other ways that teachers will discover for themselves, children who are brought up in village schools will learn to understand what they see about them, and to take an intelligent interest in the various processes of nature. This sort of teaching will, it is hoped, directly tend to foster in the children a genuine love for the country and for country pursuits.

It is confidently expected that the child's intelligence will be so quickened by the kind of training that is here suggested, that he will be able to master, with far greater ease than before, the ordinary subjects of the school curriculum.

The Board would further urge upon any teachers now in rural schools who happen themselves to be of urban upbringing, or to have been trained in urban centres, to seize every opportunity of gaining a closer insight into the special conditions and problems of rural life, and they trust that those whose previous education has not enabled them to obtain full knowledge of the main principles and phenomena of rural life and activities will be able to attend such holiday courses and classes as may be placed within their reach for this purpose by county councils or other local committees; since it is only when the teacher is genuinely interested in and well informed about the occupations of country life that any such results can be looked for in the children as have been referred to as the proper object of rural schools in the present circular.

I have the honour to be, Sir, your obedient servant,

G. W. KEKEWICH.

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EDUCATION DEPARTMENT.

*Circular to H.M. Inspectors.* Circular **369.**

## Object Teaching.

EDUCATION DEPARTMENT, WHITEHALL,
LONDON, 25*th June* 1895.

SIR—It has been observed that in Schools in which Object Teaching has been introduced with most success the teachers have carefully distinguished between two kinds of instruction which in other schools are not seldom confused. These two kinds of instruction are—(1) observation of the Object itself, and (2) giving information about the Object. This distinction is of importance, because the scope and method of the lesson differ according to its nature. Object teaching leads the scholar to acquire knowledge by observation and experiment; and **no instruction is properly so-called unless an Object is presented to the learner so that the addition to his knowledge may be made through the senses.**

Junior teachers have not unfrequently given lessons before H.M. Inspectors, which were wrongly described as Object Lessons, because in dealing with the topic selected no suitable appeal was made to the eye of the scholar.

The following suggestions, which have been made by practical teachers, will be found useful:—

The teacher should select only so many of the Objects set forth in the appended or other similar lists as can be dealt with in the year, without overburdening the scholars. Habits of observation are better cultivated by the thorough examination of a few objects than by the superficial treatment of many.

No object should be chosen which the teacher cannot thoroughly illustrate either by the object itself or by some adequate representation of the object, or by both. All that is purely technical, whether in the mode of study or the language and terminology, should be carefully avoided.

The children should be encouraged to bring with them to the lesson illustrative specimens which they have collected or borrowed from friends.

The children should be encouraged to make simple drawings illustrative of their observations, wherever possible, and in certain cases to make simple records on square-ruled paper. Clay modelling and other manual occupations may be employed to test the accuracy of the impressions which the children form, and to fix them in their minds. Teachers also should frequently illustrate details of the lesson by blackboard drawings. Children who are jaded in five minutes by a lecture will be open-eyed and receptive for half an hour while the teacher draws as well as talks.

The attempt to teach children to be accurate in observation cannot be separated from the need of making them accurate in description. After the children have been trained to observe a fact they should be practised in making a correct statement of it in a sentence of their own. This oral answering in complete sentences will lead to correct use of the English language, both in talking and writing, and will store the mind with a useful vocabulary. In the higher standards the children will be able to write brief weekly compositions in which they may express in a written form the ideas which they have acquired through oral instruction.

To sum up the main value of Object Teaching, there are three principal uses. The first and most important is to teach the children to observe, compare, and contrast; the second is to impart information; and the third is to reinforce the other two by making the results of them the basis for instruction in Language, Drawing, Number, Modelling, and other Handwork.

There are, however, other important uses of good Object Teaching. It makes the lives of the children more happy and interesting by opening up an easily accessible and attractive field for the exercise of brain, hand, and eye. It gives the children an opportunity of learning the simplest natural facts, and directs their attention to external Objects, making their education less bookish. It further develops a love of nature and an interest in living things, and corrects the tendency which exists in many children to destructiveness and thoughtless unkindness to animals, and shows the ignorance and cruelty of such conduct. The value of the services which many animals render to man should be dwelt upon, and the importance of kindly treating them and preserving them should be pointed out. By these means, and in other ways, good Object Teaching may lay the foundation for the right direction of the activity and intelligence of the children throughout the whole school.

I have the honour to be, Sir, your obedient servant,

G. W. KEKEWICH.

## EXTRACTS from the REVISED INSTRUCTIONS issued to H.M. INSPECTORS, and applicable to the CODE of 1900.

### *Object Lessons for Country Schools.*

The farmyard. Its buildings and their contents. Animals kept on a farm and their uses. Necessity of cleanliness, kindness, and suitable food.

The dairy and its contents. Butter- and cheese-making.

Bees. Bee-keeping.

Spring. Spring flowers. Work in the fields in spring. The cuckoo and swallow. Record date of arrival.

Summer. Different kinds of leaves and fruit. Work in the fields in summer.

Autumn. Work in the fields.

A mill and the work of a miller.

Winter. Frost. Ice. Snow.

Birds. Singing birds, as the thrush and nightingale. Birds of prey, as the hawk. Swimming and wading birds, as the duck and heron.

Wild Animals. The fox, hare, and rabbit.

Minerals. A mine. Three useful minerals.

The lessons on the seasons should correspond with the actual seasons of the year, and the different operations explained should be taken while each is in progress.

Leaves of trees may be dried by simply placing them between sheets of paper and pressing them. Their shapes may be used for the children to draw round on paper, which can afterwards be pricked and then sewn round.

Springtime.
- The waking of Nature.
- The lengthening daylight in the morning and evening, the coming warm weather, birds singing, building their nests, laying their eggs, the trees and hedges changing, buds and leaves, the bloom on fruit trees.

The local wild flowers of spring. The daisy, primrose, bluebell.

Summertime.

The local wild flowers of summer.

Autumn.
The local wild flowers of autumn.
Winter. The repose of Nature.
The land. Woodland, meadowland, ploughland, moorland.
The sky.
A bird—covering, wings, beak, feet ; motion ; nests, eggs, food.
Local birds.
- Thrush or blackbird.
- Lark.
- Robin.
- Rooks.

Birds which come for the summer.
Birds which come for the winter.
Local wild animals.
- Rabbit.
- Hare.
- Fox.
- Hedgehog.

Animals on a farm.
Our village.
The carrier's cart.
The cottage garden.
The stream or river, its banks, the birds and animals that live near it.
A fish.
A plant.
The garden in spring.
The farm in spring.
The garden in summer.
The farm in summer.
The garden in autumn.
The farm in autumn.
The garden in winter.
The farm in winter.
The weather and wind.
The soil ; sunshine, air, rain, frost, manure.
The farmer's tools. The plough, drill, reaping-machine.
The crops ; grass, corn, root-crops.
Wheat.
The potato.
The oak tree.
The elm tree.
The apple tree.
Evergreen trees.
An insect.
The spider and his web.
The butterfly ; colours, beauty, history.
Bees.
The farmer's pests.
The farmer's friends.
A pond.
A frog.

A ramble in a wood and what may be seen there.
The railway.
Market-day in the neighbouring town.
A newspaper.

### EXTRACTS from other LISTS in the same "INSTRUCTIONS," suggestive of COUNTRY LIFE.

#### *Plant Life.*

The study of plants as growing things.

Grow an onion in a bottle of water and note appearance of root and stem. Make a model in clay of the various stages of growth at short intervals.

Grow mustard seed on damp flannel and note stages of growth.

Notice a few curious roots.

The carrot. Cut off the top of one and grow it in a saucer of water. Contrast the root of a daisy (fibrous).

Roots which walk. Strawberry or strayberry.

Violet root.

Contrast root of Iris and Solomon's Seal in their modes of extension.

Stem. Count the rings in a trunk that has been felled. Rings, how produced; estimate age of tree; the record of wet or dry seasons.

Climbing stems. Ivy.

Train bindweed up a stick and note that it turns to the right. You unwind it and force it the other way (to the left), note how it resumes its old direction again, holding the stick with one of its leaf stalks to get a purchase for the change.

Simple experiments to show effect of light on (1) leaves and (2) roots. Celery; blanching.

Leaves of deciduous trees contrasted with leaves of evergreens. Contrast leaves of holly, ivy, and box with leaves of oak, elm, and beech.

Note autumn tints. Collect and press leaves of various colours in autumn.

Buds. Leaf buds and flower buds.

Parts of a flower. Flowers of curious shape. Pea blossom.

Fruits. Different kinds.

Insects and flowers. Colours of flowers.

Riverside plants.

Plants that grow in running water.

Plants that grow in still water.

Meadow and pasture plants. Turf on the downs, hay in the valleys.

Plants of the heath and moor.

Plants of the hills and woods.

Hedgerow trees—elms and ashes.

Trees of the forest—oak, beech, birch.

Evergreen trees—pines and firs.

Evergreen plants and shrubs—holly, ivy, box. Contrast evergreen and deciduous leaves.

Riverside trees—willows, poplars, aspens.

### *Animal Life.*

The Cat (compare with Dog).—Eyes, rough dry tongue, soft pads and sharp claws, teeth, method of holding prey, drinking, covering of fur, whiskers, tail.

The Cow (compare with Sheep and Goat).—How she takes her food, teeth, chewing, milk (cheese and butter), tail, hoofs, covering, ears, horns, nose.

The Horse (compare with Donkey).—Covering, teeth, hoofs, tail, mane.

The Rabbit (compare with Hare).—Teeth, legs, feet, claws, covering, tail, whiskers, ears, eyes.

The Mouse (compare with Rat and Water-Rat).—Teeth, paws, tail, whiskers, eyes, ears.

A Fish.—How fitted to live in water, weight, shape, covering, temperature, movements.

Animals which sleep in winter.—Examples: squirrel, dormouse, common snake, frog, toad, snail, slug. Preparation made for sleep.

Mole.—Shape, snout, teeth, paws, claws, eyes, ears, fur, food.

Hedgehog.—Covering of spines, how it rolls itself into a ball and why, head, teeth, food.

Common Snake (compare with Viper).—Shape, covering, teeth, how it moves, how it swallows its prey.

Frog (compare with Toad and Newt).—Movement, capture of prey, breathing, winter quarters.

Garden Snail (compare with Slug).—Shell, mantle, head, horns, eyes, food, preparation for winter sleep.

Earth-worm.—Shape, rings, locomotion, food, usefulness.

Spider (contrast with Bee).—Shape, segments, legs, eyes, jaws, spinnerets, web, breathing organs.

Paws and Claws and their uses.—Cat, dog, rabbit, mouse, mole, frog.

Tails and their uses.—Horse, cow, donkey, dog, cat, monkeys, harvest mouse.

Tongues and their uses.—Cat, dog, cow, woodpecker, frog.

Teeth and their uses.—Man, cat, cow, horse, rabbit, snake, fangs of poisonous snakes.

Hair, Fur, Wool, and their uses.—Cat, mole, dog, sheep, fox.

Beaks of Birds and their uses.—Duck, fowl, parrot, sparrow, goat-sucker, heron.

Feet of Birds and their uses.—Duck, fowl, swift, owl, etc.

Insects.—Examples: Bee, beetle, butterfly, cockroach, silkworm. Insect development, legs, wings, segments, mouth, breathing apparatus, ovipositors.

### *Natural Phenomena.*

**The Sky.**—Sunrise, noon, and sunset. (Note the object over which the sun is seen to rise from month to month. Note sun's position at noon, and its varying height above horizon.)

Shadow. (Note by aid of a spike erect on a flat disc the varying length of the shadow at noon. Study the shadows of objects. Variation in sharpness and depth.)

Moon. (Note the changes. Draw the shape from week to week.)

**The Air.**—Wind. Varying direction. (Note and keep record of the direction of the wind from day to day.)

Warmer and colder winds; rainy and dry winds.

Moisture in the air shown by seaweed; string (changing tension).

Wet cloth dries in the wind (water turns to vapour).

Vapour turns to water. (Breathing on slate. Clouds on hills. Evening mists.)

Clouds in the sky. Three chief kinds: "heaps," "beds," "feathers."

Rain. (Note size of drops. Raindrops on dust form little balls. Note effect of heavy rain in tearing up roads. Note the channels so made, and the arrangement of the sand and pebbles washed to a distance.)

Rainbow. (Note the succession of colours. Note position of sun behind observer and of the bow where the shower of rain is falling. Note that height of arch changes. When is it higher and when lower?)

Rainbow colours on shells, film of tar, etc. Feathers of birds.

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# BOOK III

## THE FOOD OF PLANTS

### Lesson I

### PLANT-FOOD IN THE AIR

The teacher will require a small flask, fitted with a bent tube and a thistle funnel; some pieces of marble, chalk, or limestone; some hydrochloric acid and water; gas-jars; a piece of candle and a taper; some lime-water; a small saucer.

#### I. A Strange Gas

1. *Prepare some carbonic acid gas as follows:—*

*Put a few broken pieces of marble, chalk, or limestone into a small flask, fitted with a bent tube and a funnel. Pour enough water down the funnel to cover them, and then add a little hydrochloric acid.*

*Call attention to the bubbling that at once commences in the liquid. The bubbles pass up through the liquid, and burst on the surface.*

*While the bubbling is going on, dip the other end of the bent tube into a gas-jar.*

*The gas is easily collected by downward displacement, and it would be advisable to fill three or four of the jars before proceeding.*

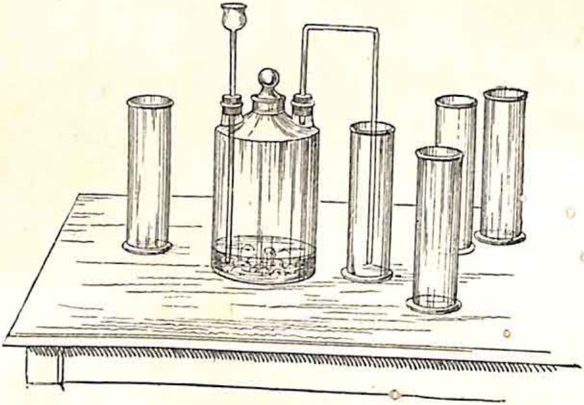
*That done, the properties of the new gas may be shown as follows :—*

2. *First let the children examine the jars. They* **see nothing**; *they* **smell nothing.**

The jars **look** as **empty** as this one. But is this one really empty? No; it is **full of air.**

Let us see then whether these are full of air too.

*Plunge a burning taper into one of them.* **The flame is instantly extinguished.** *Show the difference when the taper is re-lighted and plunged into the other jar, which contains ordinary air.*



*Elicit that there is something in this first jar, although* **we cannot see it**, *or* **smell it.** It cannot be air, because **air would not put out the flame**; it would help the flame to burn.

3. Now think for a moment.

What was there in this jar at first? Air.

What has become of the air then? Let me show you.

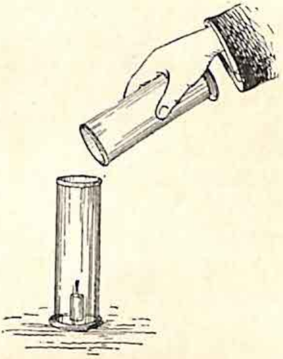
*Pour some water slowly into another "empty" jar. Notice that the water settles at the bottom.*

Why? Because **water is heavier than air.**

*Continue to pour in more water.*

What becomes of the air that was in the jar? The water pushes it up, and drives it out of the jar. The water takes the place of the air.

4. Now tell me why this new stuff, whatever it is, has poured down the tube and filled the jars, when they were already full of air? It must be **heavier than air.** Like water, **it sinks to the bottom of the jar,** and pushes the air out above it.



*Fix a piece of burning candle at the bottom of a jar containing only air, and pour the gas from another of the jars into it, as though it were water. Point out that,* **although we cannot see anything** *pouring down from the top jar into the other, we know that there must be something,* **for we observe that it at once puts out the flame of the candle.**

5. *Take a third bottle of the gas now, and pour into it some clear lime-water.*

*Explain what has been done, and then shake the jar well for a minute or so, calling upon the children to observe the change that takes place.*

**The clear lime-water becomes white and milky-looking.**

*Tell that there is only one substance that can make this change in clear lime-water, and that is a gas called* **carbonic acid gas.**

We know, therefore, that the new stuff in these jars, which we can neither see nor smell, is **carbonic acid gas,** because it gives clear lime-water **this milky appearance.**

6. *Lead the children to tell of another gas, which we once*

*made* **by heating coal in the bowl of a pipe.** *This we called* **coal-gas.** *We* **could not see it** *as it came out from the stem, but* **it took fire** *and burned, when we put a match to it.* **This new gas does not burn; it puts out all burning.**

### II. Burning and Breathing

1. *Take a clean glass bottle with a narrow neck, and lower a burning taper into it.*

*Let the children observe that, after it has burned for a few minutes,* **the taper gradually dies out.**

*Remove the taper now, pour some clear lime-water into the bottle, and shake it up.*

What do we see? **The lime-water has become white and milky-looking.**

What does this prove? It proves that there is **carbonic acid gas** in the bottle.

*Point out that when the burning taper was first lowered into the bottle, there was nothing in it but air. The* **carbonic acid gas has been formed by the burning of the taper.**

*Tell that* **all fires,** *all* **lamps for lighting,** *all* **burning of every sort, produce carbonic acid gas.**

2. *Pour some clear lime-water into a tumbler, and set one of the children to breathe, or blow air into it, through a straw or a piece of glass tubing.*

*Call attention to the change which takes place in the lime-water.*

*There is the same* **cloudy milkiness** *as we have seen before.*

What does this prove? It proves that **the air which we breathe out contains carbonic acid gas.**

### III. Carbonic Acid Gas in the Air

1. Our breath and the breath of all animals contains carbonic acid gas, and every fire that burns produces carbonic acid gas.

What becomes of it? It mixes with the air.

Look at this saucer. I filled it with clear lime-water early this morning.

What do you notice about it now? It has **the same milky, cloudy look** on its surface, as we saw in the tumbler when we breathed into the lime-water.

What does that prove? It proves that **carbonic acid gas has been acting on the lime-water.**

Where did the carbonic acid gas come from? It must have come from the air. **There is always some carbonic acid gas in the air.**

2. *Point out that there is only* **a thin film on the surface** *—the water below is clear enough.*

This tells us plainly that after all there is **only a very small amount of carbonic acid gas in the air**; and yet with fires and animals always making that gas, we might have expected to find a very large quantity of it present. How is this?

3. *Explain that* **every green plant** *which grows* **takes in carbonic acid gas from the air,** *and uses it to build up its own substance.* **It forms an important part of the food of plants.**

This is why there is never very much carbonic acid gas in the air.

It is thrown off by animals; it is produced by burning; but **plants require it as their food. They take it out of the air.**

*Notice the all-wise arrangement of this.*

Men and animals breathe out carbonic acid gas, **but they could not breathe it in.** It is a **highly poisonous gas.** It would **kill us** and all the animals round us if we breathed it, as surely and as quickly **as it killed the flame of the candle.**

**Plants take out of the air,** as their food, **the very thing that would be a deadly poison to men and animals,** if it were allowed to accumulate.[1]

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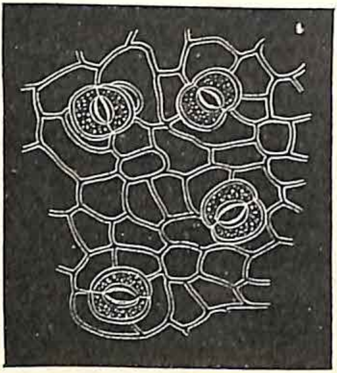
[1] *Information for the Teacher.*—Although plants breathe in

## IV. Plants as Breathing Things

1. I must now tell you (because you could not find it out for yourselves) how plants do this.



*Show a drawing of a piece of the under-surface of a leaf as seen through the microscope.*

*Call attention to the* **stomata,** *or* **breathing-pores.**

*Explain that the surfaces of leaves are* **crowded with holes** *like these; and that generally there are* **more of them on the under** *than on the upper surface.*

Look at this lime-leaf. Our eyes are not sharp enough to see the holes or pores on it, but **they are crowded thickly together,** hundreds upon hundreds in every part of the leaf. Think how very small, and how close together they must be.

2. **These holes** are called the **breathing-pores** of the leaf, for the plant **breathes through them.**

*This of course will be quite new to the children. They know that animals require to breathe, but they have never yet looked upon plants as breathing things.*

carbonic acid gas, and use it for food, they must respire as well as animals. As a matter of fact plants breathe out a certain amount of carbonic acid gas, although this is more obvious at night than during the day. Needless to say, the point may be passed over now, as far as these children are concerned; it would be utterly out of place in this lesson, and the mention of it would only fog them.

The teacher may prove it for himself, however, as follows:—Fill a bottle about half full of young leafy buds in the evening; cork, and allow it to stand till next morning, when the gaseous contents, if tested with the lime-water test, will be found to be rich in carbonic acid gas, which of course must have been given off by the leaves.

The plant actually **breathes in carbonic acid gas** through these breathing pores in its leaves. It takes from this gas (which is poison to animals) **the very thing that it wants for its own support,** and gives out the rest to the air again.[1]

### SUMMARY OF THE LESSON

1. Carbonic acid gas is invisible, and it has no smell.
2. It is so heavy that it can be poured out like water.
3. It puts out a flame; it does not take fire itself.
4. It turns clear lime-water white and milky-looking.
5. Carbonic acid gas is produced when things burn.
6. We give off carbonic acid gas when we breathe, and so do all animals.
7. Plants feed on the carbonic acid gas in the air, which is a deadly poison to us and all animals.
8. The leaves of the plant breathe it in through their breathing pores.

## Lesson II

## PLANT-FOOD IN THE SOIL

Articles required for illustration :—Three or four beakers or tumblers, the spirit lamp, and the evaporating dish and tripod stand ; a wide-necked stoppered bottle with a plugged hole near the bottom; some sugar, salt, lime, common garden mould, blotting-paper filters, some small gravel stones, a rusty nail, and a jug of water.

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[1] The teacher may prove this for himself as follows, although again the experiment would be out of place with country children, who have no knowledge of chemistry. Place a quantity of some aquatic plant (elodea anacharis for example) in a large glass of water, and stand it in the bright sunshine, when bubbles of gas will be seen coming off from it. Place over the plant a wide funnel, the whole of which should be covered with the water. The bubbles will thus be directed up the stem of the funnel, and may be collected by an inverted test-tube, full of water placed over the stem. The end of the test-tube must of course be below the surface of the water. When a sufficient quantity of the gas has been obtained, test for oxygen with a glowing splinter. This proves that the plant has taken up carbonic acid gas, separated from it the carbon it contained, and given out the oxygen which is left.

## I. INTRODUCTION

1. *COMMENCE with a brief reference to the preceding lesson. Lead the children to tell all they can of the existence of carbonic acid gas in the air—its origin and nature*—**poisonous for men and animals to breathe,** *but* **the actual food of plants.** *Plants could not live without it.*

*Elicit that the plant breathes this gas in through the pores of its leaves. It takes away from the air,* **for its own support,** *the very thing that would poison us and all animals.*

2. *This new idea of the plant feeding through its leaves has no doubt been a puzzle to the children, for so far they have always associated the feeding work of the plant with its roots. Speak of this now, and explain:—*

Plants require two kinds of food for their support.

Through the **pores of their leaves** they take in **carbonic acid gas** from the air. This we may call their **air-food.**

Their **roots** suck up other food **from the soil** in which they grow. This we shall call their **earth-food.**

In our lesson to-day we are going to deal with this earth-food, which plants get out of the soil.

## II. SOME GARDEN MOULD

1. *Refresh the children's memory by putting some sugar, salt, and lime into three tumblers of water. Stir till they disappear in the water.*

What has happened to the sugar, the salt, and the lime? They have **dissolved.** They are in the water, although we cannot see them.

How could you make sure that the salt is in this water? **By tasting** it.

How could we get the salt back? **By boiling the water away.**

What do we say about these things—**salt, sugar,** and **lime**—because they dissolve in the water? We say they are **soluble.**

What would happen to this **chalk,** if we put it in the water? It would sink to the bottom of the glass. **It would not dissolve.**

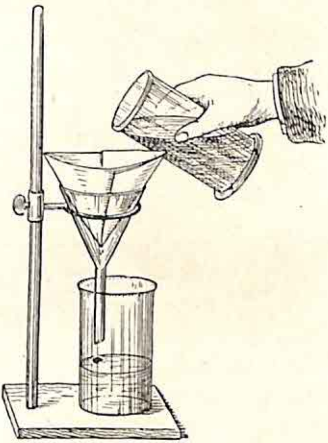
Why not? Because it is **not soluble.**

*All this is recapitulation of old work.*

2. *Put a little common* **garden-mould** *now into a tumbler or a beaker, fill it up with water, stir it well for a minute or two, and then stand it aside to settle. As the water clears, call attention to* **the sediment** *at the bottom of the glass.*

Why does all this solid stuff settle at the bottom? Because **it is not soluble.** It **will not dissolve** in the water.

We are certain then that **this part of the mould has not been dissolved.** Let us see next whether the water has dissolved any of it.



3. *Pour off the clear water into another beaker, and filter it through a blotting-paper filter.*

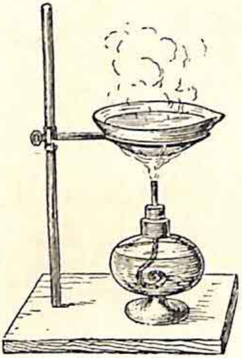
*When the filtering is over, call attention to the* **clear water,** *which has run through into the beaker below, and the* **thin layer of muddy matter** *left behind on the blotting-paper.*

This muddy stuff is left behind **because it is not dissolved.** It cannot pass through the pores of the blotting-paper.

Now look at the clear water, which has run through the blotting-paper. Does it contain any dissolved matter? We cannot tell.

Why not? Because, when things are dissolved, they are broken up so small that **we cannot see them in the water.**

4. What is a good way to get all dissolved things back out of the water? **We can get them back by boiling,** just as we got the salt and the sugar back.



Let us boil this water now then.

*Pour the solution into an evaporating dish, and evaporate in the usual way over the flame of the spirit-lamp. Call attention to the residue left behind in the dish.*

It is the solid matter which the water has dissolved out of the garden-mould. This **dissolved matter from the soil is the very food which plants require.**

5. *Call attention once more to the blotting-paper.*

Why was this muddy stuff left behind? Because it was not dissolved. It **could not pass through the blotting-paper.**

*Point out that, similarly, it is* **only the dissolved matter of the soil that can pass into the roots of a plant.** *Undissolved matter is useless as food for the plant.*

*Explain that the* **dissolved earth-food,** *which the roots obtain from the soil, is useless to feed the plant, until it has flowed upwards and passed into the leaves. In the veins of the leaves* **this sap is spread out to the air** *on all sides.* **During daylight the leaves take in from the air the very thing** (*carbonic acid gas*) **that is necessary** *to change this sap into real food*[1] *to satisfy the wants of the plant.*

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[1] The leaves are actual manufactories, and in them are elaborated, during daylight, substances which form the food of the plant. To form these materials water, with its dissolved salts (sap), is one

## III. THE WORK OF RAIN AND AIR

1. *The need of rain follows as the next natural step. There is abundance of plant-food in the soil; but it is useless to the plants until it has been dissolved.* **Nature provides water, in the form of rain, to do this dissolving work.**

Then, if water is so necessary for the soil, why does the farmer lay drains in his land to carry it away?

*This of course will puzzle the class. Proceed as follows:—*

2. *Refer them, in the first place, to the experiment they have just seen. Point out that, after all, the water in the tumbler* **dissolved only a very small part of the mould.** *By far the greater part of it is not only undissolved, but* **it is insoluble—the water cannot dissolve it.**

*Tell that, in all soils, there is* **a small part which is soluble,** *and can be taken up as food by the roots of the plant; but there is* **a much larger part** *which is useless to the plant,* **because it is insoluble.**

That which is ready for active service may be called **the active portion** of the soil; the insoluble remainder is the **sleeping or dormant portion.**

3. *It will be an easy matter to deduce from this that, after a time, the plants growing on a certain plot of land would* **rob the soil of all its active matter,** *and* **leave only the sleeping or dormant matter behind.** *Then of course they would starve.*

This is one of the chief things the farmer has to provide against.

4. *Take a wide-necked, stoppered bottle with a plugged hole near the bottom; fill it three parts full with very small stones, and then fill up with water to the neck. The water, of course, fills all the spaces between the stones. Fix the stopper*

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essential; the other is the carbon, which the leaf gains from the carbonic acid gas of the atmosphere. The surplus water is passed out into the air.

*now, and remove the plug. A few drops of water may drip through the hole, but that is all. There is no flow. Now remove the stopper, and the water at once flows freely, till none is left in the bottle. The water at first will not flow, because the stopper prevents the air from entering the bottle; but it flows freely as soon as the air is allowed to enter.*

*Explain that as the water flows away below, air must enter through the neck to take its place.*

5. The farmer drains his land, **because he wants the water to be kept in motion**—to drain through the soil, not to lie stagnant. As the water runs away through the pores of the soil, **the air must follow,** and take its place. The water makes a way for the air to enter the soil. **The soil has great need of air.**

*Explain that, in the first place,* **air sweetens the soil by destroying all sour, unhealthy decaying matter** *in it. This we may often prove for ourselves while digging in the garden.*

6. But the air does even more important work than this. *Show a rusty nail, and scrape off the red rust from its surface.* It is the air that has **acted on this hard metal,** and **changed it into powder.**

Air acts upon everything round us. It **breaks down even the hardest rocks in time,** making them crumble into powder.

*Tell that air is the very thing that is wanted* **to break down and change that insoluble sleeping portion of the soil,** *into soluble or active matter, fit for plant-food.*

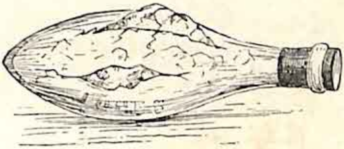
The more air we can get into the soil, **the more of this dormant matter**[1] **we shall change into active matter** fit for plant-food.

7. **The rain is Nature's great agent** for:
(*a*) Dissolving the active part of the soil.
(*b*) Admitting air to change the dormant matter into active matter.

### IV. The Work of the Frost

1. *Refer to the experiment of freezing the flask of water in a freezing-mixture of crushed ice and salt (see Vol. I. Lesson XXVI.). Better than that, if time permit, repeat the experiment now, calling attention to the flask which has burst with the freezing.*

2. *Then it will be an easy matter to apply this to the freezing of the soil in winter.* **Every pore in the soil is a tiny flask** *filled with water. The water freezes, and each tiny flask bursts, just as the actual glass flask did. Then when the thaw comes, not only does the soil break and crumble, but it* **opens up fresh passages for the air to enter,** *and do its work.*



**Frost is another of Nature's great**[2] **agents** for breaking up the soil for the admission of air.

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[1] Collect specimens of soils from several places in the neighbourhood, and analyse them by simple experiments to find sand, clay, chalk, vegetable matter (*Board of Education Circular*). All these materials have their uses in the soil, but they must be broken down and dissolved by Nature's great agents, before they can become actively useful.

[2] Illustrate further by exposing saturated lumps of chalk and wet clay in the playground during a hard frost, so that they may be examined after the thaw (*Board of Education Circular*).

## V. THE WORK OF THE SUNSHINE

1. *Compare the growing seasons of spring and summer with the desolate winter season.* **Warmth is necessary for plant growth.**

*Point out that the sun warms not only the earth, but the air above and around it. It will then be an easy step to shew that* **the passage of this warm air through the soil** must of necessity help to **warm the soil itself,** and so make it more fit to support plant life.

2. *This will lead to another reason for draining the land.*

If the water were allowed to remain stagnant in the soil, not only would it prevent the air from getting in, but **the sun's heat would be all used up in changing the water into vapour.** There would be none to warm the soil itself. **The land would be cold**—no crops would flourish in such soil.

## VI. THE PURPOSE OF MANURE

1. *Point out that, year after year,* **the growing crops rob the soil of its store of plant-food.** *A time must naturally come when it would be* **quite exhausted,** *and* **unable** *any longer* **to provide food for the plants,** *in spite of Nature's great agents.*

2. Something must be done to prevent this, or the land would become unfertile and barren. It is for this purpose that the farmer **manures his land.** He knows exactly **what kind of plant food his crops have taken out of the soil**; and he gives back to the land **these very substances in the form of manure.**

*This will be sufficient for the present.*

*Promise to say more about the matter in a later lesson.*

## SUMMARY OF THE LESSON

1. The roots of plants can take up only the dissolved matter of the soil.

2. In all soils there is a certain part which is soluble, and fit for plant-food. This is called the active portion.

3. There is also a much larger part which is insoluble, and therefore useless as plant-food. This is called the dormant portion

4. If air is allowed to enter the soil, it changes the dormant into active matter fit to feed the plant.

5. Rain and frost open up air-channels in the soil, and so increase the amount of plant-food in it.

6. Sunshine is another of Nature's great agents. It warms the land. Crops would not flourish in a cold soil.

## Lesson III

## THE GARDEN IN WINTER

### OUTDOOR WORK

1. *The boys, from their previous training, are now in a position to take an intelligent personal interest in the* **actual cultivation of a garden,** *and in many other* **practical dexterities of rural life.** *There is ample scope for practice, as every schoolhouse in the country has its garden, large or small, where they can be* **trained to handle the simpler garden tools,** *and* **to work under the guidance of the teacher.**

2. *For obvious reasons, it has been deemed advisable here to follow the plan laid down in the earlier lessons, and* **commence with the winter season—Nature's period of rest.** *The chief and almost only work now is to* **prepare the ground for its rest.** *This work of preparation must all be done before the actual frosts set in, and* **the spade** *is the implement most in request. The ground must be* **well dug,** *and* **left rough for the winter. In heavy soils** *it is advisable to* **lay the ground up in ridges,** *or* **foss;** *but* **in light soils** *it is sufficient to leave it* **in rough level beds.**

3. *The great point to be observed is that* **each spit must be turned over.** *It is not sufficient to simply stir the soil in digging.*

*This of course is hard work, but the teacher would probably find a few of the bigger and stronger boys, to whom he might entrust it, and who would follow his pattern.*

4. *Some parts of the garden will of course require manuring. The teacher will naturally call attention to the* **kind of material,** *which is put on the ground for manure. It is probably* **stable dung,** *and* **compost.** *The former may be passed by for the present, but he should call attention to the latter.*

This compost consists of **vegetable matter of various kinds,** which has been collected together in a heap, as the ground has been cleared from time to time. In the heap it has been **mixed with earth and quick-lime,** and **perhaps a little salt.** By the time it is wanted as manure, it is **well advanced towards decay.**

*Explain that, whether it be stable refuse or compost, it must be placed in heaps, then spread over the ground,* **well dug in,** *and* **covered with the soil.**

## CLASS-ROOM WORK

### I. Weary Nature Sleeps

1. *Choose a dry frosty day for the lesson, and before commencing, pay a brief visit to the garden—say during playtime.*

*Notice that the beds, which were roughed up for the winter, are now* **frozen hard**—*they are almost as hard as the path itself.* **We can walk on them.**

*Dig up a deep spit of the soil with the spade, taking care to turn it well over. Let the boys take some of this under-soil in their hands.*

*Observe that* **this is not frozen hard** like that on and near the surface. **The frost has not been able to reach** so far down.

2. *After returning to the schoolroom, let the earlier outdoor work of preparation, and the observations which have just been made, form the starting-point for further investigation.*

*The keynote to it all has been struck in previous lessons.* **This is the season for rest and preparation.** *Refer to it now.*

*Nature, like a tired man, now sleeps exhausted with her work, but when she awakes by and by, she will be refreshed, and full of vigour for further work.* **She is sleeping now to gather up her lost energies.**

**The soil has been drained of its plant-food** *by the crops which have lived upon it. That too is exhausted now;* **it must obtain a fresh supply of plant-food,** *if it is to be in readiness for the coming spring; otherwise nothing will grow in it. Proceed as follows:—*

## II. Man assists Nature

1. The garden beds, you see, are now so hard and firm that we can walk on them without sinking in. We say **they are frozen.**

But what is it that is actually frozen? **The water in the pores** of the earth.

This frozen water then holds the earth frost-bound now. But what will happen when the thaw comes? **The rough lumps will fall to pieces then,** and **crumble up into fine soil.**

Why is this a good thing for the soil? Because **it opens up fresh passages** in the soil for water and air to enter.

2. *Lead the class to tell that,* **where water soaks through, air must follow.** *Water from the melted ice will be the first to soak into the soil, but snow and rain will also do their part.*

What effect has the air on the soil? **It changes its dormant matter into active soluble matter** fit for plant food.

**The frost is one of Nature's great agents** for renewing, in the exhausted, sleeping soil, the powers which it has lost during its time of work.

3. *Deduce from this the purpose of leaving the beds* **roughly dug,** *and in some cases* **thrown up in ridges and furrows,** *for the winter.*

Man in this way helps Nature to do her work.

**The rougher the beds, the greater the surface for the frost to act upon.**

**The better the frost is able to do its work** in breaking down the soil, **the more chance will the air have** to penetrate into it.

**The more the air penetrates into the soil,** the greater will be the amount of **new active soluble plant-food** for the coming season.

*Let all this be elicited step by step.*

**Man prepares the soil, in order that it may get the greatest benefit from its period of rest and refreshment.**

4. *Remind the class, in the next place, that when we dug up the spit of soil, we found the under part of it was not frozen hard like that on and near the surface.*

Does not this part need the frost?

*Tell that probably before the winter is gone,* **the beds will be again turned over,** *in order that this part may also be acted upon by* **the great agents—frost, water, and air.**

5. *Remind them too that, in the late summer and autumn,* **many insects lay their eggs in the soil;** *and that* **slugs, snails, and other vermin bury themselves** *in it before winter comes on, to get out of reach of the frost.*

*Point out that, if the ground were left undisturbed during the winter, these slugs and snails, and the living things that* *come from those eggs, would make their way up to the surface on the return of spring, and* **do no end of damage to the tender growing plants.**

If the frost can reach them, it will kill them. **Hence by turning up the soil in winter we help to free it from vermin.**

### III. Manure to help Nature

1. *Refer next to the part of the garden that was manured, before it was left for the winter.* Let us find out now the reason for putting manure on the land.

*Point out that, as crop after crop is grown,* **the soil must become poorer in plant-food,** *even in spite of Nature's great agents. Plants would starve in it.*

What must be done in such a case?

*Remind them of the work that was done in that part of the garden. Those little heaps of manure were spread over the ground and dug in.*

2. But what kind of stuff did we use for manure? **Stable dung and compost.**

Let us think then, first of all, about that compost, for it makes capital manure.

What did it consist of? It was only **the vegetable refuse from the garden itself,** mixed with **earth** and **lime.**

Yes, but that vegetable refuse had once been the substance of living, growing plants.

What did those living plants require to make them grow? **Food.**

Whence did they get their food? **From the soil** in which they lived, and from the air.

3. *Point out in this way that, as those plants built up their own substance with materials which they got from the soil,* **the refuse matter** *of the compost* **must,** *after all,* **contain the very things which were taken out of the soil to feed the plants.**

In putting back this vegetable matter into the ground, we are only **returning to the soil that which has been taken out of it.** We are giving back to the exhausted soil **the very things it wants, to make it once more rich in plant-food.**

4. *Follow this up with a little careful, thoughtful questioning about the stable manure. It will be easy to deduce the truth step by step.*

Horses and other animals **feed on plants.** The plants build up their substance from **food, which they get from the soil.** The **very materials,** which the plants took from the soil, **are returned to it in the form of stable dung from these animals.**

5. *Tell that lime in its various forms is absolutely essential for the well-being of plants. It is* **easily slaked** *and* **rendered soluble.** *It is* **not only a manure in itself, but it helps to break up and change other substances in the soil into valuable plant-food;** *and it destroys vermin, such as grubs, slugs, and snails.*

The gardener knows exactly what kind of manure is required for his soil. **That which suits one soil will be quite unsuitable for another.**

## Summary of the Lesson

1. The gardener throws up the soil of the garden in ridges or foss before winter comes.

2. This is to help the rain, frost, and snow to get into it, so that the air may follow to do its work.

3. The frost kills vermin and their eggs, if it can reach them in the soil.

4. Manure gives back to the soil the very materials, which the growing plants take out of it.

## THE FARM IN WINTER

*During this season the farmer, as well as the gardener,* **must prepare, while Nature rests.** *He has plenty of work before him, but the work is not continuous throughout the winter.*

*One part of it*—**the winter ploughing**—*must be done* **before the actual frost sets in.** *But the* **manuring of the meadow and pasture lands** *is best accomplished* **during a spell of hard frost;** *while all the* **drainage operations** *are necessarily at a standstill during the frost and snow, and can only be carried on, when there is* **a break in the severity of the weather.**

*The teacher should seize each opportunity, as it arises, of taking the class to* **observe the various operations on the spot.** *That done, the lesson might with advantage be recapitulated in the schoolroom with the help of the Author's Pictures and Diagrams.*

*Needless to say, the plough may be seen at work during most seasons of the year. But it has been thought advisable to deal with* **the nature and work of the plough** *at this juncture, in order that the class may be able to compare* **the winter ploughing** *with what they will see going on at other times in the year.*

## Lesson IV

## PLOUGH-LAND AND PLOUGHING

### I. INTRODUCTION

*The digging operations in the garden, during the last days of autumn, to prepare the ground for the winter frosts, will naturally associate themselves in the boys' minds with* **the similar work of preparation,** *which is sure to be going on about the same time* **in some one or other of the farmer's**

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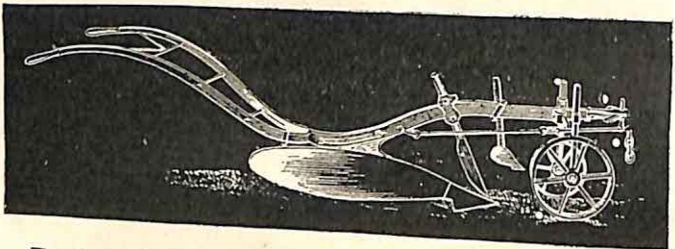
**fields.** *It should be the aim of the teacher to lead the class to* **intelligently compare the two operations.**

*This of course would be best accomplished by a visit to one of the fields, where ploughing is going on. The plough itself should first be examined on the spot, and then the class should be called upon to watch it at its work.*

## II. THE PLOUGH

1. THE PARTS OF THE PLOUGH.—*Call attention in the first place to the* **steel portion of the implement**—*the part which does the actual work of turning up the soil.*

*Notice the part in front.* This forms a sort of **vertical** or **upright knife,** and is called **the coulter.**



Behind the coulter is the **share,** the front part of which **forms a horizontal knife.**

The hinder part of the share is a sort of plate which **curves gradually from front to back.** This is known as **the breast-board,** or **mould-board.**

2. THE WORK OF THE PLOUGH.—*Lead the children, by examining these various parts of the implement for themselves, to discover that* the soil is **cut vertically by the coulter,** and **horizontally by the share,** so that the two together cut **a slice of it.**

*Now call attention once more to the* **curving mould-board,** *and show that as the plough moves along, the cut slice of soil* **is turned completely over** *by this part of the implement.*

The **under part** of the soil is **brought to the surface,** the **weeds are buried,** and one ridge is thrown up against another, **with a furrow between the two.**

3. THE WHEELS. — *Call attention to the wheels in the next place. Note that* **one wheel is larger than the other,** *and explain :—*

The large wheel is called **the furrow wheel.** It runs along **the bottom of the last-made furrow.** The small upright wheel, which is known as **the land wheel,** travels along the unploughed **edge of the land.**

*Show that this small wheel can be* **raised** *or* **lowered** *at will. Explain that when the farmer wishes* **to plough a deep furrow,** *he* **raises this wheel;** *but for* **shallow ploughing** *he* **lowers it.**

*Call attention to the ploughed fields around, and explain that* **winter is the time for deep ploughing.** For winter ploughing the plough is always arranged to **throw up the soil in deep furrows and ridges.**

4. THE BODY OF THE PLOUGH. — *Notice in the next place that the wheels, as well as the cutting part of the implement, are* **firmly riveted to the beam.**

The **long handles** or **stilts** at the back of the beam are for the ploughman **to guide the plough** as he walks behind it.

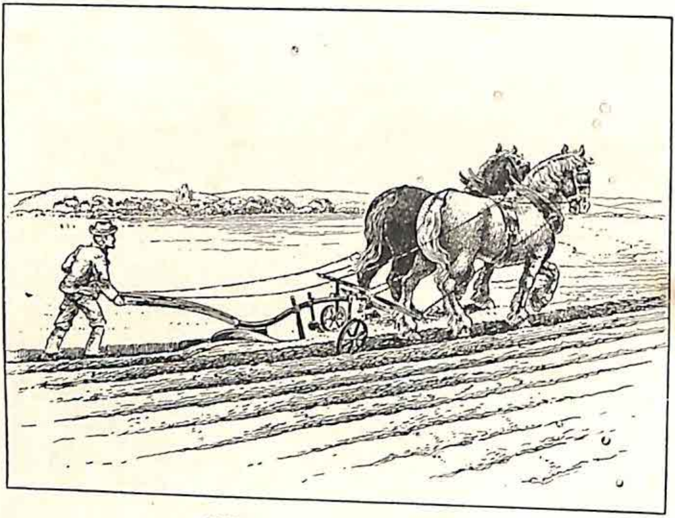
The horses are harnessed to the front of the plough **by a T-head** and **draught-chains.**

## III. DIFFERENT KINDS OF PLOUGHS

*In describing the principle of the plough it has been thought advisable to confine our attention to the simplest form of the implement. The teacher will of course in each case study his own particular locality, and deal first with those which are in common use there, afterwards comparing them with others.*

1. THE SINGLE-FURROW PLOUGH.—*Notice once more*

*that in this plough there is only a* **single cutting implement.** This plough can cut only **a single furrow at a time.** It is known as the **single-furrow plough,** and is drawn by a **pair of horses.**

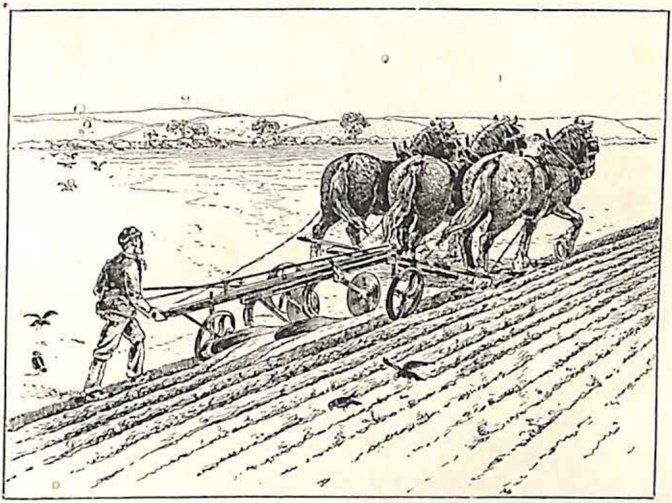


SINGLE-FURROW PLOUGHING.

2. THE SWING PLOUGH.—This implement is very similar to the above, **but it has no wheels.** The stilts are **much longer** than those of the wheel-ploughs, to give the ploughman **greater command over the machine.** This kind of plough is **largely used in Scotland,** but is seldom seen on English farms.

3. THE DOUBLE-FURROW PLOUGH.—*Show, by means of the implement itself, or a picture, that this is practically* **two ploughs in one.** It has **two furrow wheels,** and **one upright land wheel.** It is worked with **three horses abreast.**

*Tell that this plough effects a great saving of time and labour, for* **three horses and one man** *can plough as much* *land as* **two of the single-furrow ploughs,** *with a pair of horses and a man to each.*



DOUBLE-FURROW PLOUGHING

This plough is commonly used on the large arable farms of Lincolnshire and the north.

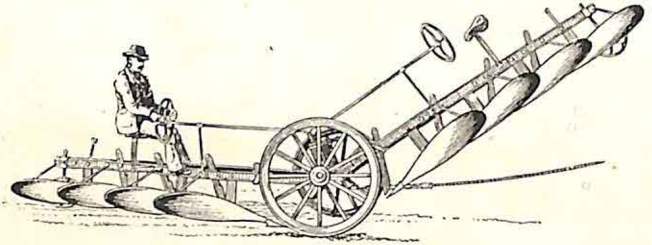
4. THE STEAM PLOUGH.—*In very many parts of the country the teacher will perforce have to be content with a picture of this implement.*

*Notice that it is practically* **in two parts.** When it is in use, **the front part is raised up** in the air, and is carried along in that position, while **the hinder part is at work cutting its way through the soil.**

Then when it reaches the opposite side of the field, that which was the hinder part is in turn raised up, **the other part is lowered ready for work,** and the implement travels back again across the field, **cutting its way through the soil as before.**

5. *Explain the principle of working :—*

**A steam-engine** is stationed on one side of the field, and **the plough itself is drawn** to and fro **by a steel-wire rope** stretching from the engine to the opposite side. The man sits on the box to guide and control the plough as it moves along.



STEAM-PLOUGHING.

6. *The class will now be in a position to take an intelligent interest in the plough. Ask them to watch the implement at work. They will observe that the ploughman is careful not to drive the nose of the plough too deep into the ground, as it moves along.*[1]

*Explain that* **the subsoil is poor** compared with **the rich soil above it,** and the farmer does not wish to have the two mixed up together. Hence the man does not let the plough dig deep into the ground.

## SUMMARY OF THE LESSON

1. The working part of the plough consists of the coulter, the share, and the mould-board.

2. These three together cut a slice of the soil, and turn it over completely.

3. The large wheel runs along the bottom of the last-made furrow. It is called the furrow wheel.

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[1] On certain lands the operation of subsoiling is sometimes found necessary, to stir the subsoil, so that water may readily drain away, and air enter to do its fertilising work. This is done either at the same time as the ploughing, or as a separate operation, but it is too intricate to be dealt with here.

4. The small wheel is called the land wheel. It can be raised or lowered at will, for deep or shallow ploughing.

5. The single-furrow plough cuts one furrow at a time. It is worked by a pair of horses.

6. The double-furrow plough cuts two furrows. It is worked by three horses abreast.

7. The steam-plough is a double machine—one half is raised in the air while the other half is at work.

## THE FARM IN WINTER

## Lesson V

## OTHER WORK IN THE FIELDS

### I. Pasture Land—Manuring

1. *This part of the farmer's work is usually done* **during a spell of hard frost,** *for then the heavy lumbering putts or manure carts are less likely to cut up the ground than at other times.*

*Choose a suitable day for a visit to one of these meadows, and on the way lead the children to tell what they know of the kind of operations they expect to see going on there.*

Shall we find the plough at work in the meadows? No; the farmer does not plough those fields.

Why not? Because that would destroy the grass, and he wants it to grow.

2. *Point out that air and water are as necessary to the soil of the meadows as to the arable land.* **They cannot act upon the soil, unless the ground is opened up in some way.**

Then as the meadows are not ploughed up, how can the soil be acted upon by the great agents?

*Explain that* **Nature steps in here,** *and* **does the**

**work of opening up the soil,** *which man cannot do. She employs* **one of the lowliest of her creatures** *to do this all-important work.*

*Lead the children to tell, from their own observation, what they know of the* **earth-worm.** *It lives in the earth. During the winter* **it makes its way deep down into the ground,** *to escape from the frost. But at all other times in the year it is constantly passing up to the surface and down again. We often see* **worms pop their heads out of the earth,** *and then draw back again and disappear. Every boy and girl can tell so much.*

*Explain that the reason why the earth-worm disappears so easily and so suddenly,* is that **it burrows holes or tunnels in the earth, just big enough to admit its body.**

3. These tunnels, which the earth-worm makes, become so many **channels or passages,** through which **water and air may enter,** to do their work in the soil.

It is estimated that there are about **50,000 earth-worms to the acre.** Think what work they must do throughout the greater part of the year in opening up the soil.

The earth-worms[1] were **"ploughers before the plough."**

4. *On arriving at the meadow, call attention to the* **putts** *or* **manure carts** *coming and going, and to the* **manure**[2] *lying about. Probably the men are already at work tossing it over the ground with forks.* **Some of it is in lumps,** *some is broken up.*

*Tell that when a sufficient quantity has been carted on to the ground and well scattered,* **a chain-harrow will be**

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[1] See Lesson XV.

[2] Note places in the field where the heaps of manure have been allowed to remain (*Board of Education Circular*). The dark-stained patch shows where the rain has been at work, dissolving and soaking out from the heap new material for the soil.

**dragged over the field to break it up** *into small pieces.*

5. Sometimes **a heavy bush is attached to the harrow.** This brushes the manure into the ground between the blades of the grass, and then the rain soaks it into the soil.

6. *Question out step by step that this farm-yard manure is obtained* **from animals, which fed on grass or hay.**

It is a most valuable manure for pastures, because **it must contain the very materials, which the growing grass will require as its plant-food.**

### II. Arable Land—Rotation of Crops

1. *Before leaving this subject of* **plant-food in the soil,** *it would be well to glance once more at the various crops, which the farmer grows on his arable land.*

*The children have probably noticed that a certain field, which last season was sown, say with barley or wheat,* **bore a root crop the season before,** *or vice versa.*

*Let this fact form the keynote for a simple explanation of the* **rotation of crops,** *as it is generally practised, remembering of course that it is* **no part of our purpose,** *either here or in any of these lessons,* **to instruct the children in scientific agriculture**—*that in fact our object is secured, if they can be led to follow intelligently the underlying principles, which account for what they see around them.*

2. *Commence to deal with this by referring for a moment to the animal world.*

*Remind the children that* **each animal feeds on its own particular kind of food,**[1] *and no other—that* **one**

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[1] In connection with this it would be well (*Board of Education Circular*) to collect and examine specimens of various neighbouring soils, and to note by visits and actual observation their respective values for the growth of various plants.

**animal would starve in the midst of food,** *which another would eat greedily. Call upon the class to give examples of this.*

3. *Tell that curiously enough* **plants,** *as well as animals,* **have their likes and dislikes.** *The substance which is essential to one plant may not be so needful to another.*

The plant-food in the soil contains **a great variety of materials.** Each plant **selects just what it wants,** and leaves all else; so that **what one plant takes as its food another rejects.**

4. The farmer, knowing this, **does not grow the same crop on the same land twice in succession,** because that would take from the soil one class of plant-food only. **The soil** itself would be **impoverished,** and the **second crop would not get sufficient food** to nourish it.

When the first crop has been removed, he cleans the land, and manures and ploughs it, in preparation for **a crop of a totally different character.** This crop flourishes during the next season, because it finds in the soil **abundance of the very food it requires** for its support. **The last-grown crop did not touch that food.** Then the next year another change is made, and so crop after crop is successfully grown on the land without impoverishing the soil.

## III. Arable and Pasture—Drainage

1. *The drainage work on the farm lands has to be carried out* **during the resting period of winter,** *and yet from the very nature of the work it must stop in times of hard frost or heavy snow.*

*The class should be taken to see the operation either of* **cutting open drains—griping,** *as it is called in some parts—or of* **laying drain-pipes.**

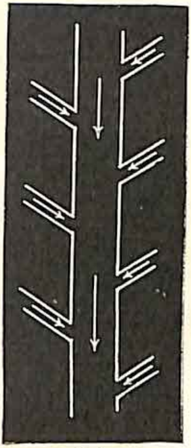
2. *On the way, lead the class to tell what they know of the purpose of draining the land.*

(*a*) **Water lying stagnant in the soil makes it cold.** Crops will not grow in such soil.

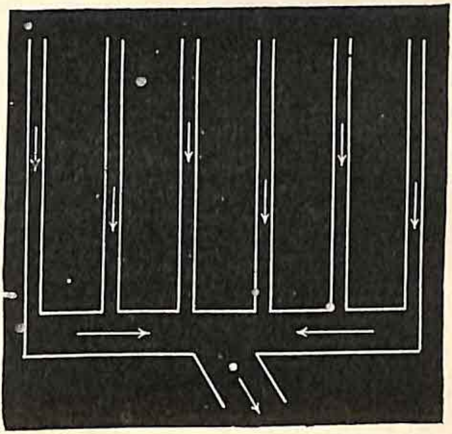
(*b*) If water fills the pores of the soil, **air cannot enter them to fertilise it.**

(*c*) The object of draining the land is to provide channels for the passage of water through the soil. **The water must flow, not lie stagnant.** As it flows away **air follows it.** *All this should now be thoroughly understood.*

3. The **open drains, gripes,** or **gutters** are cut across the field in **straight parallel lines.** They **slope gradually,** and **open into a larger drain** running at right angles to them. From this drain there is **an outlet leading into a ditch** or **water-course,** which carries the surplus water into a river.



(*a*)



(*a*) and (*b*) PLANS OF DRAINAGE.

In some districts this water-course is called a **rhyne.**

Land is also drained by **earthenware pipes,** instead of open gutters. The pipes are simply laid in the ground **about three feet deep,** and **their ends are not closely joined together.**

4. *Prove, by referring to the village wells, that there is always water under the ground. Point out that the heavy rains must* **increase the quantity** *of this underground water, and cause it to* **rise higher,** *particularly in low-lying districts.*

At such times there is **surplus water in the soil itself,** and **surplus water lower down beneath the soil.**

5. *Show from this the object of laying the pipes about three feet deep, and leaving them with the ends not closed up.*

The object is to place them so that **the surplus water from above and below may drain into them,** and be carried away.

That from above will **naturally sink through the soil,** and so flow into the pipes.

That from below will **spread upwards through the porous earth,** just as **water spreads upwards through a sponge.** Hence the water in the soil, and also that below it, can easily find its way into the drain-pipes.

### SUMMARY OF THE LESSON

1. Worms do the farmer immense service by opening up the soil.

2. Winter is the best time for manuring the land. Farm-yard dung is the best of all manures for pasture-land. It contains the very materials, which the growing grass will require as its plant-food.

3. Plants, like animals, choose their food, taking what they want from the soil, and rejecting all else.

4. The farmer grows different crops on his land year by year, so that each crop may get its proper food from the soil without impoverishing the land.

5. Winter is the time for drainage work of all sorts.

6. The land is drained either with open drains, gripes, or gutters, or else with earthenware pipes laid in the ground about three feet below the surface.

7. The object of draining the land is to cause the water in the soil to flow away.

## Lesson VI

## THE GARDEN IN SPRING

1. *There is so much to do in the garden during this busy season, and it is necessarily spread over so long a period, that the practical work and the teaching of principles must go hand in hand. In other words, the teaching will be most effective all round, if given on the spot as opportunity offers, and not in the form of a set lesson, or at one set time.*

2. *It is scarcely necessary to say that, if the boys are to be expected to take a real lively interest in the work, each should have allotted to him* **his own particular plot,** *on which* **he alone is to work** *under the guidance of the teacher, and for which* **he will be held responsible.**

*Some would prefer flowers, some vegetables. Let each follow his own choice.*

3. *Most school gardens will easily allow of this, as the plots need not be large.*

*But the* **sense of individual responsibility** *would naturally* **create a healthy rivalry** *among the boys, especially if they were promised a* **flower and vegetable show of their own** *in the summer; and it ought to be an easy matter to raise sufficient funds* **to provide a few prizes for the best results,** *for every one in the village, from the squire and clergyman downwards, would be* **glad to support so laudable an object.**

### I. Preparing the Beds

1. *Choose the earliest favourable day, and set to work, with the boys, to prepare the ground for the seeds which have to be sown.* **The weather must be dry,** and **the soil** itself so

far free from moisture, as to be **easily workable without clogging.**

*The ground, which has been thrown up rough for the winter,* **must now be dug again and levelled.** *The fork is commonly used for this. Explain why.*

The reason is that **it is not necessary now to turn each spit completely over,** and **the clods,** as they are exposed, are more **easily broken up with the fork** than with a spade.

2. *When it has been dug and levelled, the ground should be divided off* **into beds about a yard wide.** *Explain the reason for this.*

There will be plenty of work to do by and by in **weeding and thinning out.** We make the beds narrow, in order that we may be able to work them easily **without trampling on them.**

3. *As the beds are made, the boys should be set to work with the rake. Explain that the object of this raking is to* **break up all clods, clear away stones, and weed-roots,** *and leave the soil not only* **level on the surface,** *but* **fine for some depth below.**

*Lead the boys to tell how, during the winter,* **man and Nature together have in various ways been adding plant-food to the soil.**

There is abundance of plant-food in the soil now. Our object is to make it easy for the plants, **and especially the tender seedlings,** to get the full benefit from this store of food.

4. *Explain that seeds are to be sown in these beds, and lead the boys to tell the rest.* **The seedling plants,** *which come from the seeds,* **will live for a time on the food-store laid up in them.** *But when that is exhausted, and they are able to seek their own living,* **there must be an ample supply of food ready at hand in the soil.**

Hence the soil must be **very fine.** The tender delicate rootlets **would not be able to make their way into**

**lumpy soil,** which would soon become dry and hard in the sun.

### II. Seed-Beds and Growing-Beds

1. *When the ground has been properly prepared, the next business is to sow the seeds.*

*Explain that* **onions, carrots, turnips, parsnips,** *and* **radishes** *are sown in the beds,* **where they will grow till they are fit to take** *up for use. Most gardeners prefer to drill these seeds in rows about* 9 *or* 10 *inches apart.* This gives the plants **plenty of air and sunlight,** and **makes the weeding work easier.**

*Carrot-seed must not be sown in windy weather, as* **the seed is so light and feathery,** *that it is easily blown away.*

2. *Point out, on the other hand, that* **cabbage, broccoli, lettuce,** *and other seeds of a like nature, are not sown in their growing-beds; but* **in a seed-bed,** *and must be* **transplanted,** *when they are strong enough to move. These may be sown broadcast or in rows at discretion.*

*Call attention to the manner in which all these seeds are to be sown.*

They must **not be buried deep in the soil.**

*Elicit that seeds require* **warmth, air,** *and* **moisture,** *to make them germinate.*

These small seeds **could not get sufficient warmth and air,** if they were deep in the soil.

3. Whether drilled in rows, or sown broadcast, they must be covered, by means of the rake, with only **a shallow covering of soil.**

The seed must not be sown **too thickly,** or the young plants, as they spring up, will **rob each other of food, light, and air,** and **grow up puny and weak.**[1]

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[1] It would afford a more forcible illustration of the value of "*thinning out*," if a few carrots and lettuces were purposely left unthinned. The children would then have an opportunity, by and by, of comparing these "*long-legged*" plants with those that had been carefully thinned. (*Board of Education Circular.*)

Yet, if they are sown **too thinly**, there will be **gaps between the plants**, because from various reasons some of the seed usually fails to germinate.

*Point out that, should they all come up, the superfluous plants can be* **easily thinned out,** *to make room for the rest.*

4. When the seed has been sown, and the beds lightly raked over, **the soil should be made firm,** by gently patting it **with the back of the spade.**

*Show how this is to be done, and deduce the reason for it in some such way as follows:—*

I pour a little water in a saucer, and stand a dry sponge in it. In a few minutes the sponge is wet all over. Why is this?

Because the sponge is porous. **The water travels up through the pores.**

The earth too is porous, and by our digging and raking we have loosened the soil of these beds, and made it **still more porous.** The moisture, that is in the ground, **quickly rises through this loose porous soil** to the surface, and then **passes away into the air as vapour.**

5. *Point out how rapidly the surface soil dries in the sun.*

**The seeds require moisture** in the soil to help them to germinate. Hence we pat the soil down to close the pores, **so that less of the moisture may be able to escape.**

*Show that if this patting and pressing were done with the ground* **in a damp condition,** *it would* **form a hard cake on the surface,** *and the tender sprouting plants would be unable to make their way through it.* Hence **these operations require dry weather.**

6. *Precisely the same plan should be followed with the seeds of the* **hardy** *and* **half-hardy annuals** *in the flower-beds, except of course that they will be sown broadcast, and not in rows.*

*Explain the nature of each, and also the reason why some are sown later than others.*

### III. PEAS AND BEANS

1. *The same reasoning will explain why we are so late in putting in our peas and beans.*

Both are **very tender**. They are quickly **nipped by frost.** Peas are sometimes sown early, but when the young plants appear above the ground, they must be **protected at night against the late frosts,** or they will all be destroyed.

Beans, and especially kidney beans, are **more tender still.** It is not safe for them to appear above the ground, **till all danger of frost is past.**

*Explain the reason why peas and beans are always sown in rows, and why the rows must not be too close together.* They should be so placed that **both sides of the row may get their full share of the sun.**

2. After the ground has been prepared, and pressed firm, a trench 2 inches deep (and for peas 6 inches wide) is made.

The peas are **plentifully sprinkled in this trench.**

The beans are **more scattered**; sometimes they are **laid in a zig-zag form in the soil.**

Then the soil is raked over them, and lightly pressed.

Why are these seeds placed deeper in the soil? They are larger seeds; **they need much moisture in order that the food-store in their seed-leaves may be dissolved.** Their roots strike down deeper into the soil, because they grow into large tall plants. **They require more food, and firmer hold in the soil** to support themselves.

### IV. POTATO PLANTING

1. *The boys, in their earlier lessons, have been made familiar with the nature of the potato and its eyes.*

*Show one of the "seed potatoes" now. Elicit that* this is **not a true seed**. It is a part of the **underground stem,** in which plant-food has been stored.

The "**eyes**" are really **buds.** New stems are already shooting out from them, and other stems will grow from these, and spread themselves through the soil.

*Deduce from this that*, **the plants must have plenty of room to grow.** *Hence they should not be planted close together.*

2. The best method of planting is to **dig and plant at the same time**. A straight trench about 6 inches deep is cut with the spade across the newly-dug ground; the seeds (either in the form of whole potatoes, or of pieces, each containing an eye) are placed in the trench, at a distance of **about 18 inches apart**; and then the digging goes on, so that the trench is filled and covered up with soil.

As the digging proceeds, another trench is made at a distance of 2 feet from the first; this is planted in the same manner; and so the work goes on till the whole plot is planted.

3. *Point out the advantage of this method over the plan of dibbing the seed in with a dibber.* **There is no trampling over the ground after it has been dug.**

*Notice that in this potato-plot there is* **no levelling or raking,** *either before or after planting;* **neither are the clods of the soil broken up.** Why is this?

*Explain that,* at the depth at which it is planted, **the potato can obtain enough moisture from the soil to dissolve the food-store laid up in it.**

There is no need to pat the soil down close to keep in the moisture.[1] Plenty of air is necessary to make those stems grow vigorously. **Air can pass readily down between the lumpy soil.**

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[1] A dry light soil is best for a potato patch, for if there is any tendency to disease, the crop is less likely to take it when so planted.

4. *Notice that the potato is* **very tender,** *and is quickly* **nipped by frost.** *Explain that wherever the early plants are peeping through the soil, they must be* **covered up at night,** *till all danger of frost is over.* **One night's frost would turn them black and kill them.**

## V. Spring Cultivation

Weeding.—*Weeds grow everywhere with more strength and vigour than the young plants. It is hard work to keep them under, but they must be destroyed, for* **they rob the growing plants of food, light, and air.** *They themselves would grow up strong and vigorous, while the garden plants would be starved and choked, and become puny and weak.*

*Tell that* **weeding should not be done in dry weather,** *and explain the reason why.*

In the first place, it is **not so easy in dry weather,** as it is after a shower, to pull up the weeds by the roots.

Besides that, **weeding loosens the soil,** and so makes it easier for moisture to pass away from it; and if this is done at a time when the soil is already so dry that, it has very little moisture to spare, the **roots of the plants are sure to suffer from drought.**

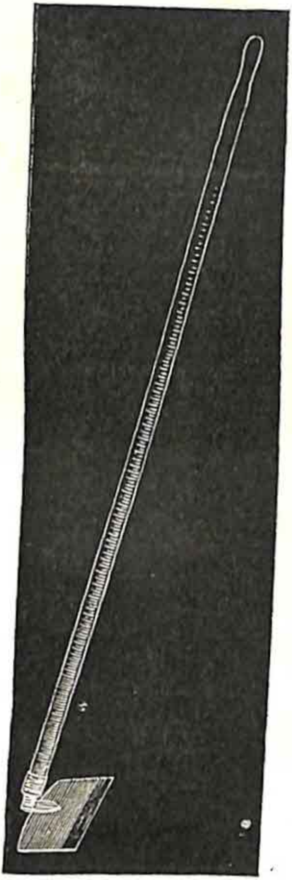
Thinning out.—*Point out that, for precisely the same reasons, this work must always be done when the soil is damp, and* **never in dry weather.**

Transplanting.—*As the cabbages and other young plants in the seed-beds begin to get big and strong, the time comes when it is necessary to transplant them into their growing quarters, where they are placed about 18 inches apart.*

In transplanting, it is usual to **break off the end of the tap-root,** for two reasons:—

(*a*) If the long tap-root were **doubled up in the soil,** the growth of the plant would be hindered.

(*b*) The plant, deprived of its large tap-root, **is induced to send out fresh roots** in all directions, in order to find food in its new quarters, and **this makes it grow strong and vigorous.**



PEAS AND BEANS.—*Lime is placed round the young pea-shoots,* **to keep away slugs and snails.** *Wire netting, or sticks with coloured ribbons, or scarecrows of some sort, are put over them* **to frighten away the birds,** *which would eat the young tender buds.*

*Sticks are placed along the rows of peas and kidney beans* **to support the plants.** *Rough branching faggot sticks are used for the clinging stems of the pea, but stouter ones for the twining kidney bean.*

POTATOES.—*As the stems grow,* **hoeing or spittling** *between the rows and round the plants is necessary,* **to cut up weeds,** *and* **to loosen the soil.**

*Then comes the operation of* **earthing up** *the rows.*

*Half of the soil between two rows is piled up lightly against the plants on one side, and half against those on the other side.* **The rows of plants are turned into ridges with furrows between them.**

*Explain the purpose of this. The young potato, being a stem, naturally* **grows near the surface.** *Should any part of it be* **exposed to the light, it will turn green,** *and quickly* **send up shoots** *from its eyes.*

The soil that is thrown up prevents this, and enables the gardener to turn out a fine crop of white-fleshed potatoes.

### Summary of the Lesson

1. The soil of the garden-beds must be broken fine, in order that the rootlets of the seedling plants may penetrate it.

2. The surface should be patted firm with the back of the spade, to close the pores, and so prevent the moisture from passing away too rapidly.

3. Weeding, thinning out, and transplanting should not be done in dry weather, for if the ground is opened and loosened, the moisture will quickly pass away from it, and the plants will suffer from drought.

4. In transplanting we break off a part of the tap-root of the young plant, to induce it to send out fresh roots. This makes it grow strong and vigorous.

## Lesson VII

## THE FARM IN SPRING

1. *The intelligent interest, which the children are now taking in their own practical work in the garden, will be sure to lead them to look with new light on the various operations, which they see going on in the fields all round.*

*It should be the aim of the teacher to stimulate this new interest, by leading them to compare the larger operations in the farmer's fields with their own work on the little plot of ground, which they are learning to cultivate.*

2. *Impress upon them that in both spheres of work the end sought is the same.*

The farmer's aim, like ours, is to make the earth yield the best possible crop.

Although the work in the fields is so vast compared with our work in the garden, yet it must be carried out on the same lines—it must be based on the same reasoning.

## I. THE FARMER'S SEED-BED

1. *Explain that, with the first awakening of spring, the farmer, like ourselves, begins to be busy. He too has seeds to sow; and he must prepare proper seed-beds for them.*

Some of his wheat was sown in the late autumn, but he has **other wheat which must not be sown till the spring,** and then he has **barley** and **oats,** and **peas** and **beans** to sow.

*His seed-beds are immense fields; ours are only little plots in the garden, but the preparation on both is very similar.*

2. SPRING PLOUGHING. — *Take or send the children, some bright morning, to watch and report upon the work that is going on in the fields. They find the ploughman busy in all directions. Watch the plough at work, and compare this* **spring ploughing** *with that, which the men were doing in the late autumn and winter.*

The plough then threw up the soil in deep furrows and ridges, but it does not turn a deep furrow now. This is **shallow ploughing**. The furrows made now are not more than 5 or 6 inches deep, and **the soil breaks up more easily,** as the plough passes through it.

3. *Compare all this with the work in the garden. In preparation for the winter frosts, we dug deep spits, and threw up the soil in rough lumps. In making our beds in the spring we* **turned the ground over loosely with the fork.**

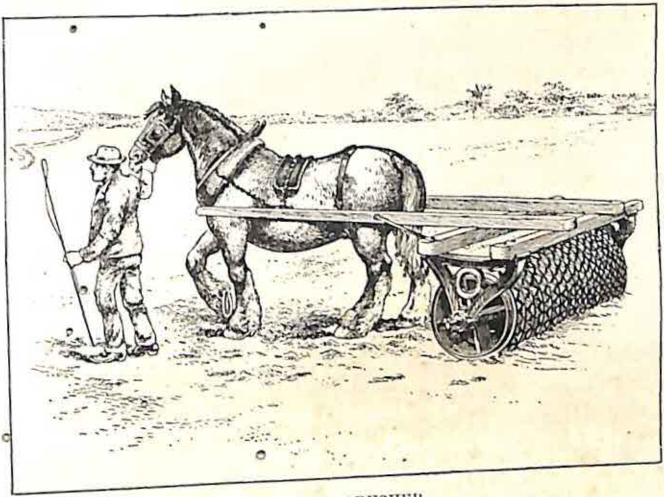
*Notice the condition of the field after the plough has passed over it.* It is still **rough,** and **full of clods.** In the garden we broke up the clods with the fork as we dug. How does the farmer break up the clods in his great fields?

4. ROLLING.—*Take them to another field where the* **horse-roller** *is at work. As they watch the work going on, call upon them to observe that two things take place.* The roller breaks up the clods, and at the same time **presses** or **consolidates the loose soil,** so as to **make a firm even bed.**

How do we make our garden beds firm and even? We pat them with the spade.

Why do we press the soil close? **To prevent the moisture from escaping** from it too rapidly.

*Point out that the farmer cannot pat his immense beds down with the spade, as we did in the garden, but after all the roller does precisely the same work.*



THE CLOD-CRUSHER.

*Explain too that the* **kind of roller** *to be used* **depends entirely on the nature of the soil.**

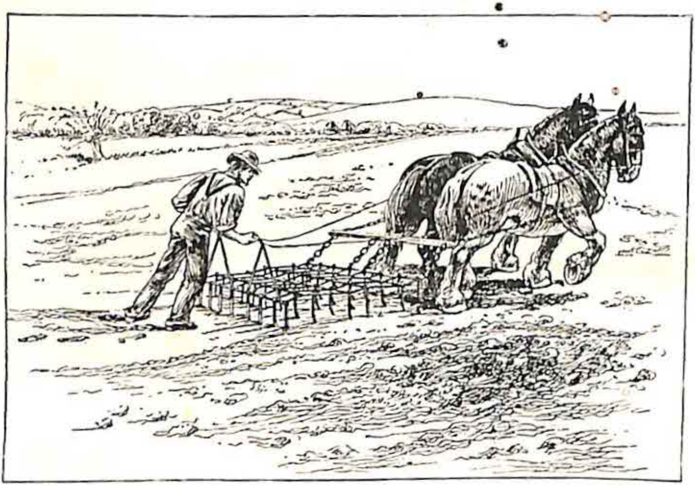
5. On some lands a **clod-crusher,** *i.e.* a **roller with sharp teeth,** is used to break up the heavy clods; on others the work is done by a **wooden roller,** because a heavier one would compress the soil too much.

*Refer once more to the similar work in the garden, and lead the children to tell why all such work* **must be done in dry weather.**

6. HARROWING.—*Pass on next to another field,* **where**

**the harrow is at work.** *The children will have no difficulty, of course, in recognising this implement as* **a monster rake.** *It is doing exactly the same work, as they do in the garden beds with their own little garden rake.*

The tines of the harrow enter the ground two or three inches deep, and break up the soil finer and finer. It is clear that the farmer, like ourselves, wishes the surface **soil to be fine and loose,** and **the under part firm.**



HARROWING.

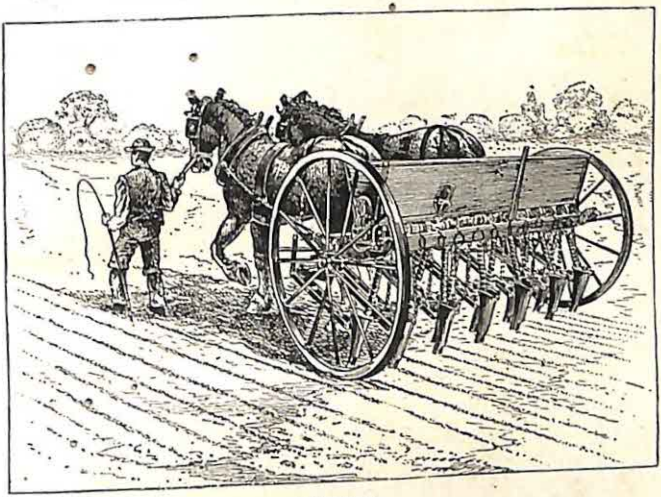
A good seed-bed for corn and other seeds must have **a firm under-soil and subsoil,** and a **fine loose well worked surface-soil.**

## II. Sowing the Seed

1. *While the class watch the drill at work, call upon them to describe it in their own way. Their earlier lessons, and their own subsequent observation, have already made them quite familiar with it.*

*Notice, in particular, the* **coulter in front of each spout,** *for cutting the groove in the soil, to receive the seeds as* *they fall. Point out that the grooves thus made are all the same distance (9 inches) apart. The man has nothing to do but drive straight across the field.*

*Show how he does this.*



DRILLING.

He himself **walks along one of the drills** already made. He holds in his right hand one end of a stick, which is **attached at the other end to the horse's bridle.** In this way he is able to lead the horse straight across the field, and **keep all the drills parallel.**

2. *Notice that the* **light seed-harrow** *follows the drill.* It is drawn over the ground several times after the sowing. *Refer once more to the garden operations, and the children will tell the rest.*

The ground is harrowed after the sowing, **to cover the seed with soil,** and at the same time **to prevent the moisture from escaping too easily.** Moisture is necessary for the germination of the seed.

3. *It might be found advisable at this stage to describe the*

*operation of* **pickling the seed,** *particularly as this introduces one of the farmer's pests—a sort of fungus growth, or disease called* **smut or black-ear,** *which attacks the grain crops.*

If the corn is attacked by this disease, every grain in the ear is destroyed, and replaced by a soot-like powder, consisting of **innumerable spores, by means of which the disease is spread.** To prevent the disease, the seed, before sowing, is either **pickled in brine for about two hours,** or else **dressed with quick-lime.** This destroys any disease germs there may be in the seed.

## III. SEED-BED FOR ROOT CROPS

1. *After observing the above operations, the children should be led to compare such crops as corn, peas, and beans with the more bulky root crops, for which the farmer is making preparations elsewhere.*

Turnips, swedes, and mangels have **big fleshy tap-roots.** The object of the grower is to produce the biggest roots possible. Hence **there must be no lack of plant-food in the soil,** for these plants are gross feeders.

2. *Explain that, in order to secure this, the farmer has to work the land specially for these crops.*

*Choose dry fine weather, and take the class to a field, which is being prepared for a root crop. Point out that the farmer began his preparations here, as soon as the corn was cut and carried last autumn.* It was ploughed then: **it is being ploughed again now.**

His first business was to **thoroughly clean the land of weeds.** When that had been done, he ploughed it deep, and left it for the winter.

3. *Elicit that* manure is wanted, to add to the store of plant-food in the soil.

*Explain why farm-yard manure is best for these crops.* The cattle are fed largely on roots during the winter.

**The manure from these animals** therefore **contains the very materials, which such plants require** to build up their substance.

*Tell that manure is commonly applied as the land is cleaned, and the ploughing then ploughs it into the soil.* But **this would not do in light soils,** for much of the fertilising matter would be washed away and lost during the winter.

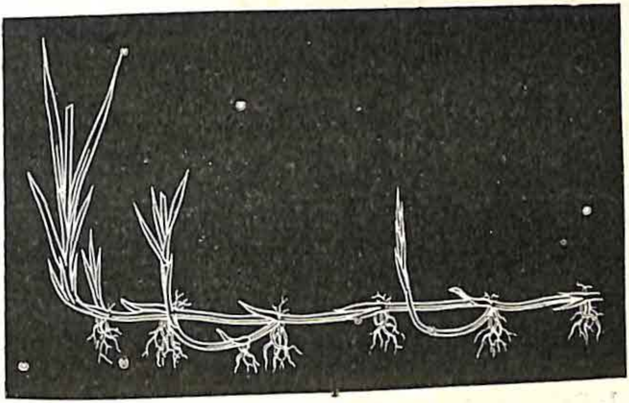
4. *Ask the class to carefully watch the ploughman at his work. They will at once observe that this is not the same kind of ploughing, as they have recently seen on the corn-lands.*

This ground **is as deeply ploughed now,** as it was before the winter. We require **a deep soil or tilth for roots.**

5. *Let them pay particular attention to the next operation of harrowing the land.*

*Notice the dry state of the soil. It is strange to see the harrow at work on this dry soil.*

*Point out that, as the harrow moves over the ground, it drags to the surface* **strings of thick whitish cords.** These are the runners or **underground stems of couch-grass,** a most troublesome weed to the farmer. The smallest bit



COUCH-GRASS.

of it will take root and grow, and as it grows it sucks the soil greedily, and **robs it of the plant-food,** which is wanted for the growing crops.

*Notice that the harrow drags it off the field, and throws it up in heaps at the side. The safest way to get rid of it is to burn it.*

6. This harrowing, besides clearing the land of weeds, secures **a fine deep soil,** which is the very thing the root crops need.

The seed is usually **drilled in** as we drill corn; but it must not be less than half an inch or more than an inch deep, or the plants will not come up, and the drills are 24 inches apart.

A light harrow is passed over the field **to cover the seed with soil,** and it is then rolled in order to **consolidate the soil** a little, and **prevent evaporation.**

7. *On heavy wet soils, and especially in the north of England, these seeds are drilled in a very peculiar way.* **Ridges,** *27 inches apart,* **are thrown up by the plough,** *and the furrows between the ridges are then* **well manured with farm-yard dung.** *Each ridge is then* **split by another ploughing,** *which turns half the soil to the right, and half to the left, so that what was a furrow* **becomes a new ridge with the manure buried beneath it.**

*The seed is drilled along the top of the ridge. In this way* **a deep rich tilth is provided,** *with abundance of plant food below, and the ridges themselves throw off the excess of moisture from the wet land.*

### SUMMARY OF THE LESSON

1. In spring ploughing, the plough cuts a shallow furrow not more than 5 or 6 inches deep.

2. A good seed-bed for corn and other crops must have a firm under-soil and subsoil, and a fine loose well-worked surface-soil.

3. To secure this the land must be harrowed and rolled after ploughing.

4. The kind of roller used depends on the nature of the land.

5. Root crops require a deep rich soil or tilth.

## OBSERVATIONS FROM DAY TO DAY

*All through the spring the children should be encouraged to make their own observations, and report from time to time on the after-cultivation, growth, and general appearance of the crops in the fields :—*

1. Rolling the Corn-lands.—One of the first operations is that of **rolling the fields,** as soon as the **young plants are a few inches above the soil.**

*Explain that this rolling* **consolidates the soil about the roots** of these plants, and enables them to **take a firmer hold of it,** and at the same time to **feed more easily.**

*Lead them to tell, from their earlier lessons, why it is that* **those fibrous roots** *have to* **begin their feeding-work very early in life.**

2. The Root Crops are not rolled.—*Direct them to observe this for themselves, and then explain the reason for the difference in treatment.*

In germinating, **turnips, swedes,** and **mangels** send down **a large tap-root** at once. Rolling would injure a root of this kind, and it would not easily grow in size, and force its way downward, if the soil had been consolidated by the roller.

3. Harrowing and Hoeing.—The other operations of **harrowing** and **hoeing** are the same for all crops. Hoeing and harrowing **remove the weeds,** and **stir the surface soil,** and in this way the under-soil is kept moist.

The roots are hoed more than the corn, because the **corn soon grows so tall that hoeing becomes impossible.** Hence the difference later on between the two crops. The corn-field is **crowded with weeds**; but the **root crop is clean,** and free from weeds.

4. THE GROWING CORN.—*It will be interesting and instructive to watch the growing* **wheat, barley,** *and* **oats,** *so that the children may learn to* **identify the three plants readily, before the flowers make their appearance.**

WHEAT.—Sown in the autumn, it may be easily distinguished from the other two by its more advanced growth. It is **taller now than either barley or oats,** for they are both[1] sown in the spring. As spring advances, too, its **lower blades have a yellow, withered appearance,** which is never seen in the other two.

The farmer went to his wheat in May,
But he came saddened and silent away;
The farmer went to his wheat in June,
And came away singing a merry tune.

Wheat looks thin on the ground and yellow in May; but the old saying tells us that—

A warm June puts all in tune.

But besides this, it is known by its **upright growth.** The stalks are **erect, smooth,** and **slender**; the **joints are far apart,** and hence there are **comparatively few leaves.**

The leaves themselves **stand up well round the slender stalk,** the upper part of each one bending over in a graceful curve.

**The ligule,** which holds the blade to the stalk, **passes completely round it,** and has a **hairy appearance.**

N.B.—*This is the surest test of all, and of course can only be made clear by close and careful examination and comparison of the growing plants themselves.*

OATS.—The plants are **not so tall as the wheat.**

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[1] Barley is always a spring-sown crop, but some oats are sown like the wheat in late autumn.

The leaves are usually **as broad,** and **as dark in colour** as the wheat, but **instead of standing up round the stalk, they spread more,** and **curl in growing.** They have a **flaggy appearance.**

The stalks, as well as the leaves, are **rougher to the touch** than those of the wheat; the **joints in the stalk are closer together,** and hence there are **more leaves to each plant.**

**The ligule passes three parts round the stalk**—not all round it, as it does in the wheat plant. *Show this in a growing specimen.*

BARLEY.—These plants are **about the same height as the oats**; but the **leaves are long, narrow, smooth,** and of a **much lighter green** than either of the others.

**The ligules pass only half way round the stalk,** and are **not hairy.** The **joints** in the stalk (like those of the oat) are **closer together** than they are in wheat. Hence the plant at this time of the year has a **more grassy appearance** than wheat.

## Lesson VIII

## THE GARDEN IN SUMMER (1)

### I. NATURE AND HABITS OF PLANTS

1. *As summer advances, the school garden, divided off into its separate allotments, ought to look a picture of neatness and promise.*

*Under the watchful guidance of the teacher each young amateur gardener is becoming an enthusiast, anxious to win the first prize in the forthcoming flower and vegetable show, and proud to feel that what he looks on is all of his own growing.*

2. *Now that the garden is in this flourishing condition, the teacher should take the opportunity of impressing upon the*

*children that, much of the success depends upon the care that was taken in planting out.*

3. *Compare the growing plants one with another, and lead the children to tell that* plants are **not all alike in their nature and habits.** What would suit one is unfavourable to another.

One plant **revels in sunshine**: it should have **the sunniest spot** in the garden. But this position would be a bad one for others, as they seem to **require shade** rather than sunshine. They **droop and flag in the hot sun.**

4. Some plants again seem to delight in **moist** and **even wet situations**; but others would droop and die there, as they prefer **a fairly dry soil.**

Strange to say, although most plants love a rich deep soil, there are some that **flourish best in a poor and scanty one.**

*Illustrate each case with living, growing examples.*

Each plant must have just what is suited to its needs, if it is to be grown with success. Hence the gardener **must know the nature and habits** of all his plants.

*In connection with this the teacher should not fail to take the opportunity, during some well-timed outdoor ramble, of finding and examining, with the children, some of the* **wild relations of their cultivated plants of the garden,** *such as the* **carrot,** *the* **potato,** *and the* **cabbage.**

*The specimens collected might be either dealt with on the spot, or if more convenient, carried back to the school, to be compared with the garden plants to which they are related. Proceed as follows :—*

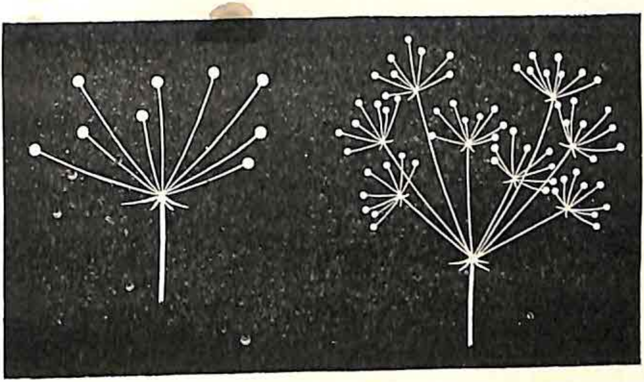
## II. THE CARROT AND ITS WILD RELATIONS

1. The carrot family is a widely distributed group, and has many representatives among the **wild plants of the meadow** and **wayside.** Chief among these are the **cow-parsnip, wild carrot, cow-bane,** and **hemlock.**

*Take the cow-parsnip first, and after dealing with that, pass on to collect others of the family to compare with it.*

*This plant, which is common everywhere,* **by the roadside** *and on the* **margins of meadows and pastures,** *blooms continuously through* **July and August,** *and of course that would be the best time to seek it.*

2. *Without giving its name, or any hint for the present as to its relationship, call attention to this* **tall plant,** *with its* **wide-spreading clusters of small white flowers.** *Notice that the flower-stalks all spring from one point,* **something like the ribs of an umbrella.** *Lead the children to tell that they have already observed the same thing in the flowers of the* **fool's cress** *(Book II., Lesson XXXV.).* **Such a cluster of flowers is called an umbel.**



*Examine this one more closely now, and point out that* **the flower-bearing stalk divides twice** *in this umbrella fashion.*

The main stalk divides into a number of **radiating ribs,** and each of these **again divides** in a similar way, and **bears a flower on its summit.** We call it **a compound umbel.**

3. *After noticing the* **dark-green, feather-like leaves,**

*pull up the plant, and call attention to its* **long spindle-shaped root.** *Then, still without mentioning the name of this plant, turn to find the* **wild carrot,** *which is almost sure to be growing not far off. Having found a suitable specimen, proceed to compare the two. Lead the children to discover that*, in both plants, the **root, habit, leaves,** and **flowers** bear a strong resemblance.

*Cut away the flower-bearing stalks of each plant now, and ask the children to think of some plants in the garden, which resemble these, and so let them discover for themselves that they have been examining* **a wild parsnip,** *and* **a wild carrot.**

4. *Elicit that* our parsnips and carrots are **biennials.** They do not flower till the second year. We never see them in flower in the garden, **because we take them up for use** at the end of their first season.

*Tell that if the carrots and parsnips were left in the ground, and kept secure from the winter frosts, they would bear* **umbels of flowers,** *exactly like these wild ones.*

*Promise to let one of each of these garden plants remain in the ground, to flower during the next season.*

5. *Proceed now to find, and compare with these, some of the other wild members of the family, such as the* **cow-bane, hemlock,** *and* **fool's parsley.**

*Explain that the cow-bane and hemlock are both* **virulent poisons,** *and that, although some members of these umbel-bearing plants* **provide wholesome food, the family as a rule are dangerous,** *and ought to be avoided.*

*The* **hemlock** *is known by its peculiar* **mousy smell,** *and its* **spotted stalk.**

6. *Point out that among the cultivated members of the family we have* **celery, parsley,** *and* **fennel,** *in addition to the carrot and parsnip.*

But even **celery in its wild state** is **very unwholesome—almost poisonous.**

We earth up the celery plants in the garden, for the purpose of shutting them **away from the light.** The plants, deprived of light, not only **blanch or turn white,** but **lose the power of developing their poisonous properties,** and so become wholesome for food.

## II. THE POTATO AND ITS WILD RELATIONS

1. *Tell now that other plants in the garden, as well as carrots and parsnips, have their wild relations, and then endeavour to find the* **deadly nightshade,** *and the* **henbane.** *Both are to be met with on* **waste lands,** *and* **near old ruins and rubbish-heaps.**

The **deadly nightshade** is known by its **straggling stems,** its **large purple bell-shaped flowers,** and a fruit, something **like a small plum, or a glossy black cherry,** where the flower has fallen off.

2. *Examine the plant carefully*—**leaves, flowers,** *and* **fruit**—*and warn the children against those tempting-looking berries.* **They are a deadly poison, and have often proved fatal to children.** *They are sometimes called* **the Devil's Cherries.**

*Tell the name of the plant*—**the deadly nightshade**—*and show by comparison that it is* **a near relation of our useful potato.**

Although the potato itself is a valuable food-producing plant, **many of its relations,** like the deadly nightshade, **are poisonous.**

*Point out the* **henbane** *next—a smaller plant than the other, but also* **a virulent poison.**

It is a noxious **unpleasant-smelling weed,** about eighteen inches in height, with **hairy stems** and **leaves,** and **dingy yellow purple-veined flowers.**

*Crush one of the leaves, and note the unpleasant fetid smell.*

*Tell that among cultivated plants the* **tomato** *and* **tobacco** *are members of the same family.* But it is important to remember that tobacco yields, when distilled, **a most virulent poison—"oil of nicotine."**

## IV. THE CABBAGE AND ITS WILD RELATIONS

1. *In the fields and on waste land by the roadside a familiar plant, known as the* **yellow rocket, land-cress,** *and* **bitter winter-cress,** *is often met with. Endeavour to find it now, and have it carefully examined.*

It grows about two feet high, and may be recognised by its clusters of **small yellow four-petal flowers,** for the plants are now (July) in bloom.

YELLOW ROCKET.

*Pluck some of the leaves and let the children taste them, to note their* **peculiar bitter taste.** *It will remind them of the* **water-cress.** *Explain that both belong to the same family. Notice that, where the flowers have fallen, a* **pod is left behind,** *similar to that of the water-cress and the wall-flower.*

This is a hardy plant; **its leaves remain green all the winter.** It was formerly much used as **a winter salad.** Hence its name—**bitter winter-cress.**

*Lead the children to think now of the* **mustard** *and* **cress** *in the garden. Explain that these plants belong to the same family.* If they are allowed to grow fully, they will produce the same **four-petal flowers.**

*A very familiar wild plant*—**the hedge-mustard**—*will probably be found growing close by. Find it and examine its flowers and pods.* It is a member of the same family.

*Now lastly give the children a surprise. Tell that among our cultivated plants, not only* **mustard** *and* **cress,** *but* **cabbage, water-cress, sea-kale, cauliflower, broccoli, turnip, radish,** *and* **horse-radish** *all belong to this class of plants.*

The family comprises many varieties of plants, but there is **not a single poisonous plant among them.**

### SUMMARY OF THE LESSON

1. The carrot, parsnip, celery, parsley, and fennel belong to the same family as the cow-bane and hemlock.

2. The flowers grow in umbels, and many of the family are poisonous plants.

3. Celery loses its unwholesome properties by being earthed up, and kept from the light.

4. The deadly nightshade and henbane belong to the same family as our useful potato. Both are poisonous plants.

5. The tomato and the tobacco plant belong to the same family as the deadly nightshade.

6. The cabbage, broccoli, cauliflower, turnip, radish, mustard, cress, and water-cress belong to the same family as the yellow rocket and wallflower. This family does not contain a single poisonous plant.

## Lesson IX

## THE GARDEN IN SUMMER (2)

### I. WEEDS AND WEEDING

1. *FOLLOWING on from the subject of the preceding lesson, the weed pest would naturally form the next matter for consideration.*

*All through the growing period* **the weeds,** *as a matter of course,* **have been very troublesome.** *It has been hard work to keep them under.*

*One of the first problems to suggest itself to a thoughtful boy while engaged in this weeding work, would naturally be:* **Where do all these weeds come from?**

*The teacher would do well to anticipate this inquiry on some suitable occasion, for the benefit of all the class.*

2. *Point out that we* **sow our garden seeds** *in the most suitable spots, and* **tend the young growing plants** *with every care from day to day, in order that they may come to perfection.*

*These weeds are plants too. But* **no one sows the seeds for them; no one looks after them.** *They are* **wild plants;** *they grow up without any care from us, for they are hardy and vigorous. In fact,* **they grow in spite of all our efforts to get rid of them.**

3. *Still the question, as to where the weeds come from, remains unanswered.*

*Remind the children that* although no one sows the seeds for them, yet weeds, like all other plants, **must grow from seeds.** There are seeds in the ground, and from those seeds the wild plants spring and grow.

Now where did the seeds come from, and how did they get into the ground?

4. *Show a* **ripe thistle-head,** *or a* **dandelion flower.** *Call attention to the little bits of* **light feathery down,** *which come from it, if we shake it or blow it. Notice how the wind blows them about. Tell that* **they** are **the fruits of those plants.** Like all other fruits, they come from the flowers, and contain the seed. When they are ripe, the wind is able to blow and scatter them in all directions, because they are so light. **The wind sows the seeds of many weeds.**

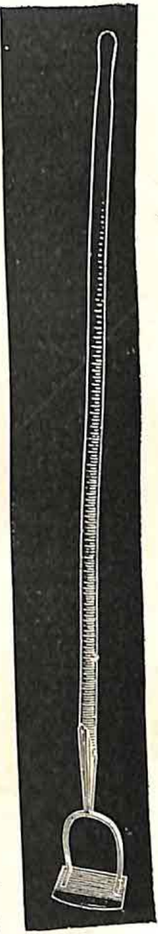
5. *Remind the children that many kinds of birds, such as the finches and linnets, which live on insects and grubs earlier in the year,* **turn their attention later on to the seeds of weeds,** *as they ripen.*

These birds drop some of the seeds as they feed, and thus they, like the wind, **become sowers of weeds.**

6. *Point out, in the next place, that weeds are as different one from another, in their* **nature and habits,** *as the garden plants are.* Hence we have to adopt **different means of destroying them.**

Some have simple **fibrous roots.** It is an easy matter to get rid of them, either by **pulling them up** with the hand, after a shower, or whenever **the ground is moist,** or by **cutting them up with the hoe.**

*A small* **Dutch hoe** *is the best for this purpose; but the boys must use it with care, or they will cut down plants as well as weeds.*



7. *Find a* **dandelion** *and a* **dock** *somewhere, and proceed to cut them up with the hoe, as other weeds are cut up. Call attention to the* **thick solid tap-root,** *which has been cut through by the hoe.*

Weeds of this kind are **very vigorous growers,** and they **drain the soil of its plant-food.** The hoe is not enough for them. Wherever they are met with, they must be eradicated completely. If a piece of the root like this were left in the ground, **it would grow again as strong as before.**

8. *Refer lastly to the* **underground stems** *or* **runners** *of the* **couch-grass,** *and the* **bindweed.**

These are among the most troublesome of weeds, both to the gardener and the farmer.

We have seen how the farmer clears them out of his land by **repeated harrowings.** Should they get into the garden, the only way to extirpate them is to **trace these underground stems** carefully, **take up every bit,** and **burn it.** The stems are very brittle; if it is done carelessly, they will easily break, and **the smallest piece left in the ground will grow.**

9. *Compare the garden plants with the farmer's crops once more. Point out that* **weeds interfere with the perfect growth of plants**; *that it is the gardener's aim to promote their growth by every means in his power. Hence* **he destroys weeds.** *He is* **constantly weeding.**

*Tell that the farmer is quite as anxious* **to promote the growth of his young corn.** *Hence he* **hoes up weeds,** *and keeps the land* **clean at first,** *and all this while the corn is growing vigorously. There comes a time at last when the corn is so tall, that* **it is no longer possible to get amongst it,** *to clear away the weeds. But he does not trouble about the weeds amongst the tall corn.*

**It has grown now as much as he wants it to grow.** The flowers will follow, and the grain will ripen in the sun **in spite of the weeds.**

10. *Compare this with the root crop. He wants the* **mangels, swedes,** *and* **turnips** *to* **keep on growing,** *as long as they are in the ground. They are placed at good*

*distances apart, and the field is* **constantly weeded.** *It is* **always clean.** *There are* **no weeds to interfere with their growth.**

### II. VERMIN PESTS

*The boys will soon learn to their cost that, they have other enemies to fight besides weeds, if they wish to protect their growing plants.*

**Slugs** *and* **snails** *begin to attack the seedlings in the seed-beds almost from the first.* **Caterpillars, maggots, earwigs,** *and the tiny* **green-flies** *or* **aphides** *seem to be everywhere.*

*Gardeners have various devices for catching or destroying these pests. The teacher of course will instruct each boy how to deal with his own particular plot, and at the same time will not fail to make capital for the whole class out of any special case that may arise.*

Nothing but a **vigilant searching of the plants** from day to day will keep these living pests under.

Remember, **prevention is better than cure.** The more effectually **the winter frost** has been allowed to do its work in the soil, **the fewer of these living pests will there be** in spring and summer to devastate our gardens.

*These garden pests will be dealt with later on.*

### III. WATERING

1. *The boys already know that plants cannot grow without moisture, and this little knowledge is* **likely to be the cause of trouble,** *unless they are carefully directed in the matter of watering.* **Too much** rather than too little is almost sure to be their **cause of failure** at first.

2. *Point out that :—*

(*a*) **The soil requires to be kept slightly damp, but not wet.**

(*b*) The amount of moisture **depends upon the nature and habits of the plant.**

(*c*) **Early morning** or **evening** are the best times to apply water.

(*d*) A good careful watering **about twice a week** (or three times in very hot weather) is **better than a mere sprinkling every day.** A sprinkling like that **wets the surface-soil only**; this is rapidly dried again during the next hot sun, and **the under-soil,** where the roots are, **is left without moisture.**

3. *Compare the garden plants with the farmer's corn in the matter of watering.*

The farmer **does not wish the corn-plants to go on growing,** and so produce long, strong straw. He **grows the corn for its ripe seeds**; and seeds ripen without moisture, by the heat of the sun. The occasional showers of spring are quite sufficient for the corn while it is growing.

In the garden it is not ripe seeds that are wanted. The gardener wishes to produce **large roots** or **leaves,** and **big pods full of seeds,** which he picks while they are **still green or unripe.** Hence **the growth** of his plants **must be encouraged** by careful watering.

## IV. Gathering the Increase

1. Summer is the season when Nature begins to yield to man her reward for his long and patient toil.

*It would be a good plan for the teacher to write down from the boys' own observation, the general* **time for commencing to gather each kind of vegetable,** *and the* **period embraced in the gathering,** *noting also the reason why one garden continues to yield a certain vegetable longer than another. The paper containing these observations should be pinned up in a prominent place in the school.*

2. Peas and Beans.—*The boys of course should take part in the various gatherings.*

*Show them the correct way to pick these pods. The stalk should be held in the left hand, and the pod broken off with the right, to avoid injuring or tearing the plant.*

Peas and beans are gathered daily; but we select which to pick, as all are not fit to gather at the same time. The plant will continue to flower, and produce new pods after each picking.

3. *Explain that* **the closer these are picked, the greater will be the yield.** *It is the function of the plant* **to produce ripe seeds,** *and after each picking of the unripe ones, it will* **put forth renewed efforts in the form of fresh flowers and pods.**

*Point out that it is exactly the same with the flowers in the flower-garden. In a well-stocked garden there need be* **no fear about cutting flowers** *for the table, so long as it is judiciously done.* **It is the business of these plants to produce seeds,** *and* **as the flowers are cut,** *they will* **renew their efforts to send out more.**

4. ONIONS AND POTATOES.—*The onion beds and the potato plot are worth notice now.*

The onions are no longer growing upwards. Some time ago we bent down their tall rounded leaves, and so bruised them that **their further growth was hindered.**

The result is that **the strength of the growing plant** is now centred in the **enlarged bulb** at the bottom of the stem. This is daily increasing in size.

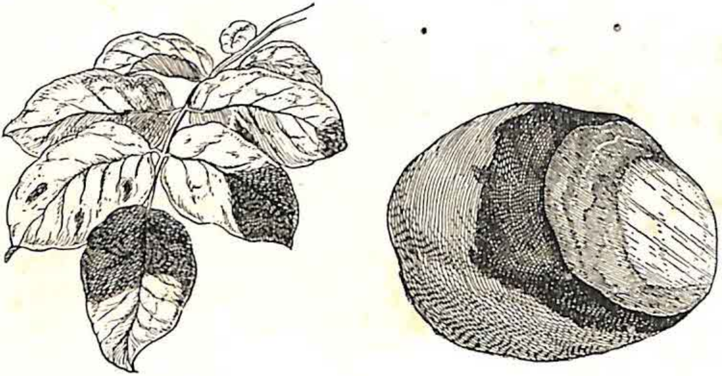
5. In the potato plot **the haulm or stems of the earlies** are **withered,** and the **leaves are brown.**

This tells the gardener that **the tubers are ripe** and fit for taking up.

*Compare these with the later sorts in another plot.* The **haulm and leaves** of these are **still green**; they are **full of flowers,** and **seed-vessels.** These have **no tubers yet worth digging.** They will not be ripe till the late autumn, and then stems and leaves too will be entirely withered and gone.

6. POTATO DISEASE. — *During the season the teacher should be on the look-out for the potato disease. In the event of an attack, either in his own or any other garden, he should take the children to examine the diseased plants, and give them a short lesson on the spot.*

The disease is the result of a **fungus growth,** which sometimes **attacks the plants about June,** and especially in **wet seasons,** and on **heavy land. Those planted on light dry soils usually escape.**



POTATO LEAVES AND TUBER DISEASED.

The diseased plants are readily recognised by **the reddish-brown spots and blotches,** which appear **on the leaves,** causing them after a time to **shrivel up and wither.**

As the disease spreads, **the stalks turn black and rot away,** and by that time the tubers themselves become infected, and the white solid flesh of the potato assumes the appearance of **a loathsome spreading sore.**

### SUMMARY OF THE LESSON

1. Weeds are plants which grow wild. They are strong and vigorous, and unless they are eradicated they will choke and kill the tender garden plants.

2. Weeds with fibrous roots may be pulled up when the ground is moist. Those with tap-roots must be dug out completely. Those with underground stems or runners are the most troublesome of all. The runners must be taken up and burned—every bit.

3. Slugs and snails, caterpillars, earwigs, and green-fly, or blight—aphis—are among the most troublesome of the gardener's living pests.

4. The growth of the garden plants must be encouraged by careful watering.

## Lesson X

## THE FARM IN SUMMER

### I. OUTDOOR OBSERVATIONS (JUNE)

1. *The children should be encouraged, as usual, to make their own observations, and report upon the kind of work they see going on in the fields during their rambles. Commencing with the early summer-time, say the month of June, they will report that:—*

(*a*) The work among the corn **gradually ceases,** as the corn-plants grow tall. It is **impossible to hoe** and **weed** these fields any longer.

(*b*) The **peas and beans** in the other fields **are hoed later** than the corn; but at last **hoeing ceases** in these fields too.

(*c*) The **field peas are not sticked,** as ours in the garden are.

(*d*) The root crops are still **constantly hoed.**

(*e*) The meadow-grass is **in flower.**

(*f*) The wheat, barley, and oats begin to show flower.

2. *Compare the growth of the peas and beans.* The beans have **erect stems,** but the **long straggling stems of the peas** spread about and cover the ground.

*The children will readily deduce from this the reason, why* **peas cannot be hoed** *so many times as beans.*

*Call attention to the* **poppies, charlock,** *and* **other weeds,** *which now begin to make their appearance among all these crops, and* **especially among the corn.**

**Nothing but constant hoeing will keep down the weeds.** As soon as the hoeing ceases among these crops, the weeds begin to grow vigorously.

*Prove this by comparison with* **the root crops,** *which are still kept* **clean and free from weeds,** *because they are* **hoed from time to time** *all through the growing season.*

3. Charlock among the Corn.—*The poppy has already been dealt with in the earlier lessons. It would be well to take this opportunity of noticing* **the charlock,** *for it is* **one of the most troublesome weeds,** *which the farmer has to contend against.*

CHARLOCK.

*Pull up one and examine it closely. Tell nothing; but let the children discover for themselves the following points:—*

It grows about **two feet high**; it has an **upright branching stem,** and a **simple fibrous root.** Its **leaves** are **rough,** with **saw-like edges**; they are somewhat **oval in shape,** and are **arranged alternately.**

It is **an annual**—it flowers and seeds in the one season. The flowers last from **May** to **July.**

4. *Examine the flowers themselves next, leading the children, step by step, to tell that:—*

They are **four-petal flowers,** and they also have **six stamens,** just like those of the **wallflower, water-cress, land-cress,** and the flowers of the **cabbage family. Charlock and all these belong to the same class of plants.**

Indeed, in some parts of the country, **charlock is often boiled and eaten as a vegetable,** when other vegetables are scarce.

*Remind the children that this family does not contain a single poisonous plant.*

The flowers are a **bright yellow colour,** and towards the end of June, when they are most abundant, the whole corn-field **glows with their golden hue.**

When hoeing becomes impracticable, the farmer usually employs boys to uproot the charlock, as long as it is possible for them to get among the growing crops. **This prevents the troublesome weed from seeding.**

5. *Explain next, with regard to the peas, that* **the yield would no doubt be greater,** *if the plants were provided with sticks, but still the increase* **would not be sufficient to repay the farmer** *for the extra expense in time, labour, and faggots.*

6. *Notice that the appearance of the* **flower in the corn-plants** *and the* **meadow-grasses** *is an intimation to the farmer that, he will soon* **commence to reap the reward of his long and patient toil.**

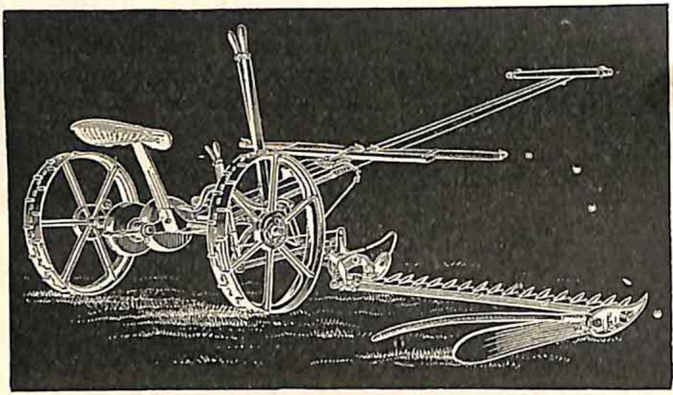
A very busy time is now coming on. The men will be **at work early and late,** and the work will go on **through the rest of the summer and autumn,** for the **hay, peas, beans, corn,** and **root crops** have all to be **harvested** one after another.

## II. The Hay Harvest

*Take the children into the hay-field to watch the hay-makers at work. The operations of cutting, making, and hauling have* *already been dealt with in a simple way, suited to the capacity of the children (Book I., Lesson XXXI.).*

*Briefly recapitulate now, making* **the time to cut and the value of proper drying,** *the chief points. But before doing this it would be advisable to let the children examine the mower itself, not with the view of entering into the details of its structure, but simply to enable them* **to follow intelligently the working of the machine.**

THE MOWER.—*Notice the* **rigid steel bar,** *which runs out* **from the right side of the machine.** *Point out that the front edge of the bar is* **grooved,** *and that* **a knife with a saw-like edge** *works rapidly from side to side in this groove.*



THE MOWER.

*Notice the* **row of steel fingers,** *which project forward in front of the bar.*

The fingers hold the grass in position against the bar; the knife does the cutting, as it moves from side to side in the groove.

But what causes the knife to move from side to side in this way?

*Explain that the whole machinery* **is put in motion by**

**the revolving of the wheels,** *as the horse draws the mower along. The driver has nothing to do but sit in his seat.*

*The position and purpose of the* **track-board** *should be pointed out. Show the* **swathes,** *where the machine has passed.*

1. Cutting.—*Careful observation on the spot will enable the boys to arrive at the following conclusions :—*

Grass should be **cut when in flower,** *i.e.* when it is **in full vigour of growth,** and **before the seeds have ripened.**

In this condition **the seeds** are soft, and **not easily shaken out.** The **stalks** and **leaves** also contain their **natural juices,** which make them **valuable as food for animals.**

2. If the grass is left too long uncut, **these juices dry up,** and the leaves and stalks become **hard and dry**—a sort of woody fibre with **no nourishment in it.**

*Remind the children of the* **two kinds of hay tea,** *that were made in an earlier lesson—one from the* **exposed,** *the other from the* **inner hay** *of the rick. That will make it all clear.*

1. Drying.—The drying agents are the sun and air.

If the grass is properly dried, **the water or moisture alone passes** away ; **none of the valuable food material is lost.**

If it is dried too much, it will **lose colour and goodness.** If it is not dried enough, it will **heat in the rick,** and probably catch fire.

2. *Tell that rain will quickly* **soak out the valuable juices** *from the cut grass, just as the hot water did from the hay.*

Rain injures the hay, and retards hay-making. The hay must be so left at night, that should rain fall before the morning, **it will do the crop as little harm as possible.**

For this purpose the **grass is put up into cocks** at night. So left it is safe from rain, and **the ground near it has a chance to dry.**

3. *Let the boys thrust their hands into a cock, that has stood all night.* It is **very warm in the middle.**

*Explain that* while the grass is piled together in the cock, **it cures,** or in other words, **it heats a little.**

Then when the cock is opened on the dry ground in the morning, **the moisture readily passes off in vapour** because of this warmth. This is another reason for cocking the grass.

4. *The boys may know the good old-fashioned test as to whether the hay is fit to haul or not. If they do not know it, show them :—*

*A wisp of hay is twisted up tightly with both hands, and then unwound and felt. If it has* **a warm dry feel,** *it is* **fit to haul**; *if the squeezing brings* **sap or moisture to the surface,** *it is a sign that it is* **not sufficiently dried.**

## III. MAKING THE RICK

1. *Follow the loaded waggons to the stack-yard, and let the children watch the* **work of rick-making.** *The nature of the rick has already been dealt with (Book I., Lesson XVI.).*

*Notice now the* **staddle of straw or other litter,** *which is laid on the ground as a thick bed for the hay to rest on. Elicit that the purpose of this is* **to protect the hay from any damp,** *that might rise from the ground. The children will no doubt remember, and be able to tell the injurious effect, that damp has on the hay.*

2. *Notice in the next place how the men and boys* **tread, and trample, and press the hay,** *as it is piled in, and lead the children to tell the purpose of this.*

The farmer wishes the hay to **lie close in the rick,** so that the air may be kept from it. By and by, when the rick is cut for use, there will be a distinct difference between the hay on the outside, and that which is further in, **where the sun and the air cannot act upon it.**

3. *Notice next that as the stack rises higher and higher, the rick-maker, who is always one of the farmer's most trusted hands, is more and more careful to see that,* **the outside of it is well pounded.**

*Point out that* the better this is done, the less deterioration there will be of the outside hay, **because the sun and the air will not be able to penetrate it** to any great depth.

4. *There will probably be one or two finished ricks in the yard. Let the children examine these now, to note the closeness of the hay, the neat tidy appearance of the stack itself, and the* **covering of thatch.**

*Observe that as a thick staddle is necessary to keep damp from rising from the ground, so a* **good thatch is equally necessary** *to roof in the hay, and* **protect it from rain.**

What makes straw such a good material for keeping out the rain?

## SUMMARY OF THE LESSON

1. During the early part of the summer, the work in the fields consists of hoeing the crops, and keeping them clear from weeds.

2. Charlock, one of the farmer's most troublesome weeds, belongs to the cabbage family of plants. It is known by its bright yellow flowers.

3. With the haymaking season the farmer's busiest time begins; for all the rest of the summer and autumn he is at work early and late.

4. The mower cuts the grass by means of a knife with a saw-like edge, which moves rapidly from side to side in the groove of a steel bar.

5. The track-board leaves the cut grass in swathes as the machine moves on.

6. Grass must be cut when in flower; and it requires careful drying.

7. The great object to be secured in stacking the hay is to protect it from the action of wet, sun, and air. The best hay comes from the middle of the rick.

## Lesson XI

## THE FARM IN SUMMER (HARVESTING)

### I. Peas and Beans

*The harvesting of the pulse-crops later on in the summer will afford opportunities for careful and valuable observation on the spot.*

1. Beans.—*Compare some old beans and peas with :—*
(*a*) *Those that are being cut, and*
(*b*) *Those that have been hauled.*

The seeds in the pods are **soft and green** compared with the old ones.

The change is brought about **by lengthened drying.** Even those that have been **dried and hauled,** are **not so hard,** nor of the **same colour,** as the **old ones.** They must dry more in the rick.

2. *Watch the work of cutting as it goes on.*

Beans are cut either with **a reaping machine, a scythe,** or **a hook.** They are then tied up with straw bands, and **placed in stooks** to dry, after which they are carted to the farm, and **built up into a rick,** where they remain sometimes for a year, before they are threshed.

3. *Examine the bean straw.*

It is **stout, rough, and stiff.** When the rick is made, it is not pressed very firmly.

Consequently **air can readily pass through it.** The result is that **the beans become dry, hard, and brown,** but do not heat in the rick.

**This black straw** is often cut into **chaff,** and moistened, to make **fodder for horses.** It is also used as **stable bedding.**

The beans are eaten whole, or as meal, by horses, sheep, and pigs. They are very nutritious.

1. PEAS.—*A close examination and comparison of peas, old and new, will reveal the fact that,* **peas are cut before they are ripe,** *when the* **haulm and pods** *are a* **greenish yellow** *colour.*

If they were not cut till they were ripe, **the pods would burst** in the handling, and a large quantity of the **seeds would be scattered and lost.**

2. *Watch the work of cutting as it goes on.*

Peas are **cut with a hook,** and always before they are quite ripe. Hence **they require much drying** before they are fit to stack. If they were ricked without being well dried, the **peas would heat and go mouldy.**

*Notice that, as they are cut, they are* **piled in small heaps,** *called* **wads.**

*These are gently turned from time to time to enable all parts to dry.*

Why gently? Rough handling would burst the pods and scatter the seeds.

*Explain that when they are sufficiently dried, they are carted to the farm, and* **stacked in a rick.**

3. **Pea haulm,** when **cut into chaff,** makes good food for cows and sheep. Peas make a valuable flesh-forming food for young stock—calves, lambs, and pigs. They are eaten either whole or crushed into meal.

*Draw attention to the important fact that, all parts of these pulse crops are* **eaten on the farm by the animals,** *whose* **manure is returned to the land.**

There is **no waste** in these crops; all parts are used, and **most of the plant-food,** which they took out of the soil in growing, is **returned to the land** in the form of **manure.**

## II. The Corn Harvest

1. *The time for this* **varies with the locality.** *In some parts of the country the harvest begins* **about the end of July** — *almost directly after hay-making. In other parts the corn is not fit to cut* **till September.**

*The following observations and teachings, however, apply of course in every case. The teacher must suit the time to the locality. In one district he will treat it as* **part of a summer lesson,** *in another it will* **go with the autumn operations.**

2. Wheat is cut **about six weeks after coming into ear,** and before it is quite ripe. The grain is then **somewhat soft still,** and **the straw slightly green.**

*Let the boys bite through some old wheat, and some of the new grain taken from the ear. Let them also chew pieces of old and new straw.*

*Lead them to tell, from former observations,* why the wheat is cut before it is fully ripe.

In the unripe state **the grain is not easily shed,** while it is being handled. **It will ripen in the rick.**

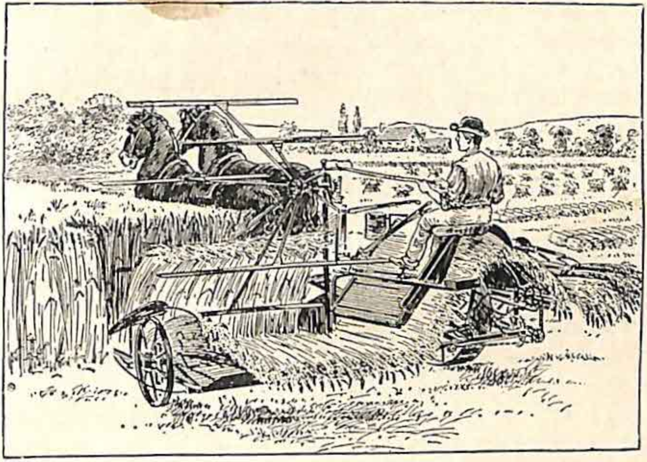
3. *Point out, on the other hand, that it* **must not be cut too soon,** *or the grain will* **shrivel up** *small. This fact will become apparent, if the class are shown some dried garden peas.*

*Tell that if wheat be cut* **after it is ripe,** *the husk (or bran) is found to be thick and very brown. The miller calls this* **weak wheat.** *But if it is* **cut at the proper time,** *the skin is thin and golden, and he calls it* **strong wheat.**

Cutting.—*Watch the work of cutting as it goes on, and, if possible, find an opportunity of letting the children examine the machine itself on the spot.*

*If the* **twine-binding reaper** *is in use, it should be compared later on in school with the ordinary* **self-delivery machine** *by means of pictures, or* vice versa. *But it should* *be carefully borne in mind that, it is* **not at all desirable** *to worry the children with* **intricate details of the machinery.** *The only thing necessary is to give them* **an intelligent grasp of the way in which it does its work.**

THE TWINE-BINDING REAPER.—*Notice, in the first place, that the cutting is done by the same sort of contrivance as we found in the mower.* There is a **saw-like knife** working from side to side in a **rigid steel bar.** The bar and knife, however, are **on the left side of the driver.**



THE TWINE-BINDING REAPER.

*Notice next that, as the corn is cut, it falls on* **a sort of platform made of canvas.**

*Point out that the canvas itself is* **stretched round two rollers,** *so as to form* **a wide endless band.**

As the rollers revolve, they carry the band round with them, and so **the cut corn is carried along** on this platform to the other side of the machine, where it is **tied in a bundle or sheaf, before it is cast off.**

*Explain that* formerly corn was always cut with a

**sickle.** Some is even now cut with the **scythe,** but most of the reaping is done with **reaping machines.**

As it is cut, it is bound into **small bundles** or **sheaves,** and put into a **stook** to dry. If it were ricked before drying, the corn would **heat,** become **mouldy,** and **ferment.**

1. DRYING.—*Thoroughly examine one of the stooks now, noting carefully its position* **in relation to the points of the compass.** *Speak of the injury rain would do to the wheat. This will assist the children to intelligently describe a stook.*

**A dozen sheaves** are stood up together, **six on either side,** the heads of those on one side resting against the heads of those on the other, so as to form a triangle with the ground. A pile of **sheaves so arranged is called a stook.**

The stook is placed so that the **sun may shine equally on both sides.** All the sheaves have thus the same opportunity of drying, and should any rain fall, it readily runs off the sloping straw. **Wheat remains in the stook for a few days.**

2. *Compare the straw of wheat and barley. The latter is found to be* **rougher—more flaggy,** *as it is called—than the former. Hence* **water cannot so easily run off.**

*Tell that*, on this one point, rests the main difference in the treatment of barley and other corn crops.

*Examine a field of barley, while it is being cut. Bite some of the grain, and handle the straw.*

3. Barley is allowed to get **fully ripe before it is cut.** The **straw is white,** the **grain is hard** and wrinkled, and the **ears hang heavily** to one side—it is said to be **sickle-headed.**

It is **cut with the scythe,** or **a reaping machine,** and it is **not generally tied into sheaves,** because being already ripe it **does not need much drying.**

Besides, rain cannot readily run off the barley straw.

It would soak into the sheaf, which would then have to be untied in order to dry the ears. Barley ricks must be quickly thatched.

**Oats are treated like wheat**, but remain longer in stook.

### III. MAKING A CORN-RICK

1. *The making of the rick is a most important part of the business of harvesting, and the boys should be taken, if possible, to see the actual work done.*

*They have already been made familiar with the nature and purpose of these ricks (Book I., Lesson XXXII.). They know that, in stacking each of his crops, the farmer has a special end in view, and* **he builds the ricks to secure that end.**

2. *Lead them to tell all they know of this, either in class or on the way to the farm, and they will be ready, when they get there, to take an intelligent interest in every step of the work from the first.*

*It would be more real still, if they could get permission to take some small share in what was going on—such as handing up the sheaves to the rick-maker, or placing the inside sheaves in order.*

3. *As the work goes on, note the following points:—*

(*a*) None of the corn is allowed to rest on the ground. The rick is **built on short stone pillars**, so that there is **an open space underneath it.**

(*b*) The sheaves are placed **with the heads in the middle of the rick**, and the straws pointing outwards.

(*c*) In this way the middle of the rick is kept **higher than the outside**, because the heads of the sheaves are more bulky than the straw. Hence **the straw slopes downwards** as well as **outwards.**

*Lead the class to tell the advantage of this.* **Rain cannot run into the rick**, but drips off the ends of the straws.

*Notice too that, although the heavier middle part is sure to* *settle down more than the outside, yet it is built up so high, that the slope is always kept.*

(*d*) The farmer wants **a free draught of air through the rick.** Hence he places it on those pillars, and in building up the stack **he does not press and pound the sheaves,** as he does the hay in making a hay-rick.

(*e*) As the rick gets higher, the sides bulge out more and more. This again protects the rick from rain, which, instead of running down the sides, **drips off from the overhanging eaves.**

(*f*) A good **thick thatch** is put over the top, the sides are neatly trimmed, and there the corn is left to stand, **till it is dry enough to thresh.**

### SUMMARY OF THE LESSON

1. Peas and beans, wheat, barley, and oats have all in their turns to be harvested and stacked in ricks.

2. Wheat and oats are cut before they are fully ripe. They are stood in stooks to dry before they are carried.

3. Barley is allowed to get fully ripe before it is cut. It does not need much drying. It is stacked in the rick at once, and the rick is thatched as soon as possible.

4. The reaping machine cuts the corn with the same sort of saw-like knife working in a grooved bar, as we find in the mower.

5. Both machines are set in motion by the wheels, as they travel over the ground.

6. Corn is stacked in ricks to dry and harden, so as to make it fit for threshing. The stack is built to allow a constant draught of air through it.

## Lesson XII

## THE GARDEN IN AUTUMN

### I. WORK STILL TO BE DONE

1. *THE children's interest must not be allowed to flag now that their flower-show is over and past. True, the garden is losing*

*its beauty and even its prim neatness little by little. But there is still plenty of work for willing hands.*

*The constantly falling leaves alone provide daily work, for they must be* **swept up,** *to keep the walks and paths tidy.*

**Apples** *are the only fruit left on the trees; they must be* **gathered** *now and* **stored.**

*The* **onions, carrots,** *and* **parsnips** *must be* **taken up** *and* **stored** *too, and the* **main potato crop** *has to be* **dug up,** *and* **prepared for storage.**

2. *The boys, of course, can take part in all this. Be careful to impress upon them the necessity for* **drying the fruit and vegetables thoroughly** *before storing them.*

*Fine weather should be selected for this work, and they should be* **laid out in the sun to dry,** *as they are gathered and dug up.*

*The* **storage** *should be a* **dry, dark room, secure from frost.** *The potatoes, if placed in heaps, should be* **turned over occasionally,** *or they will become warm and moist.* What would happen then?

3. *When the ingathering has been completed, note the* **untidy desolate appearance** *of the garden beds.* **Dead haulm** *is lying about in all directions, and this, in addition to the* **fallen leaves** *and* **weeds,** *gives the garden a* **ragged look.** *There is plenty of work here.*

*Taking advantage of the fine days, set the boys to work to* **clear away and burn** *all this rubbish, and then the ground will be ready for* **manuring, ridging, and trenching,** *in preparation for the winter. They are already familiar with this part of the work, and will require* **supervision rather than instruction** *now.*

## II. THE EFFECT OF AUTUMN

1. *While the various operations are going on, there will be ample opportunity for little chats and observations, and the dying appearance of the plants would naturally suggest a comparison of one with another.*

2. ANNUALS.—*Notice the withered decaying look of certain of the plants. Pull one of them up. Point out that, not only are the* **leaves withered and dead,** *and the* **stem shrivelled up,** *but the* **root** (*a fibrous one*) *is* **withered and shrivelled too.** *It came easily out of the ground, for it* **seemed to have lost its hold upon the soil.**

These plants are dead. Their work is completed; **they have lived long enough to produce ripe seeds.** There will be other plants to take their places next year. **Their short life is over.** We call these plants **annuals.**

3. BIENNIALS.—*Compare them with the* **onions, carrots,** *and* **parsnips.** *Elicit that these have produced* **no flowers, no seeds,** *so far.*

**Their green tops,** like the stems of the annuals, have **withered and died down.** They die because the upward flow of sap, checked by the cold nights, has little by little decreased ; **the supply of food has thus stopped ;** and hence decay sets in.

4. *The children will readily tell that, although the upper part of such plants is dead,* **the lower part is still alive.** *Throughout the growing seasons these plants have been* **storing up a food-supply**—*the* **onion in that bulb,** *the* **carrot** *and the* **parsnip** *in those* **large tap-roots.**

*Explain that we take them up,* **to save them from the frost.** *But for the frost they would remain* **alive in the ground,** *and next spring they would* **commence to grow again** *on that store of food which is laid up.*

We call such plants **biennials.** They live **two years ;** they do not **flower** and **seed** till the **second year.** *Bi = two.*

5. PERENNIALS.—*Call attention, in the next place, to plants which* **shed their leaves,** *but otherwise* **do not die** *at this season of the year.*

*Cut a twig from a tree, and notice the point where the leaf-*

*stalk was joined to it. At this spot there is* **a bud.** *Cut it open, and show the* **tiny leaves closely folded up.** We have already called the buds **the cradle of the leaves.**

6. This is clear evidence that the plant is not dead. It has **stored up food in its stem,** and on this reserve store it will **live till next spring.**

The warmer air and moisture of spring will **cause these buds to swell,** and **finally burst into leaf,** and new life will begin again—and so it will go on **year after year.** We call such plants **perennials.** *The name means that they* **live on year after year.**

### III. PRUNING

1. *Lead the children to think of the peas and beans, and the abundance of pods which we gathered from them from time to time, while they were living, growing plants.* The **more we picked, the more the plants blossomed,** and **the more the young pods grew.**

*Remind them that it was exactly* **the same with the annuals** *in the flower-garden.*

As the flowers were cut or plucked, **fresh ones made their appearance** again and again, as long as the plants lived.

*Explain that* the constant picking increases the growth of flowers, fruit, and seeds, because **the aim of all such plants is to produce ripe seeds** to perpetuate the species.

2. *Compare those plants with the perennials.*

Perennials live from year to year, and hence their **energies are not solely directed towards producing seeds.** They strive to grow larger and more bushy.

Look at these apple-trees and plum-trees. Why do we grow them?

We wish to get a good crop of fine fruit from them.

3. *Show that here we have an instance where man's wishes*

*and Nature's tendency are opposed. Man wants a plentiful supply of fruit;* **the tree, left to itself, would produce luxuriant woody growth, but only a little fruit.**

For this reason man must **check the tendency of the plant to produce wood,** and **encourage it to produce fruit.** His aim is to turn and direct the growth of the plant in this direction, because experience tells him that, **the growth of wood interferes with the production** of a plentiful supply of good fruit. What would you advise him to do?

He must **cut back the growing shoots,** and even lessen the number of the fruit-bearing branches. But he must be careful **to leave some buds** for future growth. **This cutting is called pruning.**

4. *Point out, as curious facts, that,*

(*a*) *Some plants, such as* **gooseberry and black-currant bushes,** *produce their fruit* **on the young wood;**

(*b*) *Others, such as* **red and white currant bushes, on spurs of the old wood;**

(*c*) *Others, like the* **cherry-tree,** *on wood of the* **previous year's growth,** *and* **on old spurs;**

(*d*) *and others, again, like the* **plum-tree** *and the* **apple-tree,** *on* **young** *and* **old wood alike.**

(*e*) **Pears** *grow* **mostly on the old wood.**

5. The gardener must know the **nature and habits of the various trees and bushes,** before he attempts to prune them.

He must **cut out the old branches** of certain plants, and **cut back the young shoots** of others.

He finds it advisable, even when the fruit grows on the young wood, **to shorten the new shoots,** because by doing this he concentrates the energy into a shorter space, and **larger fruit is the result.** But on this shortened shoot he **must leave some buds.**

6. *Cut a branch from a tree now, and let the children touch the cut ends. They are* **moist.**

*Explain that* **this moisture is sap.** It is the **food of the plant**—that which provides for the growth of wood and fruit as well. It is the **blood of the plant.**

It **flows abundantly** during the **spring** and **summer;** but it is gradually getting less and less now, and by and by it will **cease to rise altogether till winter is over.**

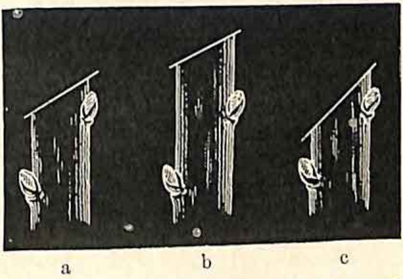
*Explain that the gardener* **must not cut or prune, while the sap is flowing** *freely, for that would* **make the tree bleed.** The valuable food would be wasted, and the growth of the plant retarded.

7. Pruning is always done in **late autumn or winter,** when vegetation is at rest. Trees and bushes **do not bleed then if they are cut.**

*It must always be done* **in mild weather,** *and* **not when frost is likely,** *for the* **frost** *would penetrate into the wound, and* **destroy the young bud.**

8. *Select now a tree or a bush in which* **the sap is down,** *and proceed to show how the pruning knife is to be used.*

*The shoot should be cut* **on a level with the bud, on the opposite side to it, and in an upward direction.** *The cut end will then terminate* **a little above the bud.** *The reasons are evident:—*



(a) Right way; (b) wrong way—too much wood left; (c) wrong way—too oblique.

The bud is protected by the part of the **shoot** left. No sap-channels running into the bud are cut. There is no wood left to decay beyond the bud.

### SUMMARY OF THE LESSON

1. Fruit and vegetables should be thoroughly dried in the sun and air before they are stored.

2. Annuals have fibrous roots; they die down in the autumn after producing flowers and seeds.

3. Biennials do not flower and seed till the second year. They contain in themselves a supply of food to start the second year's growth.

4. Perennials live for many years, producing flowers and seeds every year.

5. Trees left to themselves produce luxuriant woody growth, rather than fruit and seeds.

6. The gardener's aim is to check the growth of wood, and encourage the growth of fruit.

7. For this purpose he prunes the trees; he cuts out the old branches of some, and cuts back the young shoots of others.

## Lesson XIII

## THE FARM IN AUTUMN

### I. HARVESTING ROOT CROPS

1. *It has already been pointed out on several occasions that,* **turnips and swedes** *are generally* **fed on the land where they grow,** *while* **mangels are always dug up and stored** *as a winter food, either in pits or in food-houses in the farm-yard.*

*The class should watch, and report upon the digging and storing of these important roots.*

Mangels[1] are dug or pulled **before they are ripe.** The leaves are not then dead; there are still young ones growing from the crown.

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[1] "Mangel wurzel" means "Famine Root" in German. It is so called because it was formerly used for food in time of famine. In England these roots are often improperly called "mangolds."

They are left lying **on the ground to dry.** When the leaves are withered they are fit to be carted and stored.

2. *Let the children see a pit prepared.*

A hole, pit, or trench, about 7 feet wide, is dug in the ground, and here the roots are placed in layers **on a bed of straw,** and with straw between each layer and the next. The straw **keeps the heap ventilated,** and **prevents the roots from heating and rotting** in the ground, as they would if closely packed.

The heap narrows towards the top. The straws stick out beyond the sides of the mound, and the mound itself is **thatched with straw,** and held down by **straw bands** and **clods of earth.**

Packed in this way, mangels are safe from frost, till they are wanted as food for the animals.

3. *Call attention to the* **sheep in the turnip fields.** *Turnips and swedes are dug and* **sliced up,** *to feed the animals* **on the ground.**

*Cut one of these roots. It contains* **much water.** *Refer to the watery nature of cooked turnips or swedes.*

*Explain that, as these roots contain so much water, the farmer gives the animals* **some dry food,** *such as* **hay** *or* **cake,** *to eat with them.*

*Point out how* **the sheep improve the light soil by treading and manuring it.**

These roots are very large. They must have taken much plant-food from the soil while growing. The chief part of this is **now returned in the manure of the animals that eat them.**

## II. A Winter Food not Harvested

1. *It would be an easy and natural step now to refer the children to the* **cow-cabbages,** *which they saw the men planting out in the fields a few weeks ago. It no doubt struck*

*them as strange that, these young plants should be put in the ground so late in the year.*

*Explain that they are quite* **hardy**; *they will* **stand there all the winter**; *the* **frosts will not kill them.** *Indeed, before the winter is over, they will have grown into fine great cabbages, and will then form* **a valuable change of food for the cattle,** *till the return of spring brings the new grass.*

2. *Notice how wide apart they are set*—the great **drumhead** variety is planted **27 inches from plant to plant.** This is to give them **room to grow.**

*Point out that there is* **no need to harvest and store such a crop** *as this. The cabbages, when full grown, are cut and eaten the same day.*

### III. AUTUMN CULTIVATION

1. *Lead the boys to think of their own work in the garden during the growing seasons. Remind them that, often and often, their work was in danger of being* **ruined by one enemy** *or* **another.**

What were your worst enemies? **Weeds, slugs, grubs,** and **insects.**

How do we deal with such enemies? We use every means in our power to destroy them.

*Point out that the farmer, like the gardener, has all these enemies to contend with; he* **must wage incessant war** *with them.*

2. *Elicit that* **slugs bury themselves,** *and* **insects lay their eggs in the soil** *during the autumn. There they would remain snug and cosy in the earth, till the return of spring, when the warm sun would* **bring out the one,** *and* **hatch the other set of enemies.**

What would be a good way to reduce the number of enemies for next year? Destroy them **while they are buried** in the ground.

3. This is the farmer's plan. Can you tell me how he

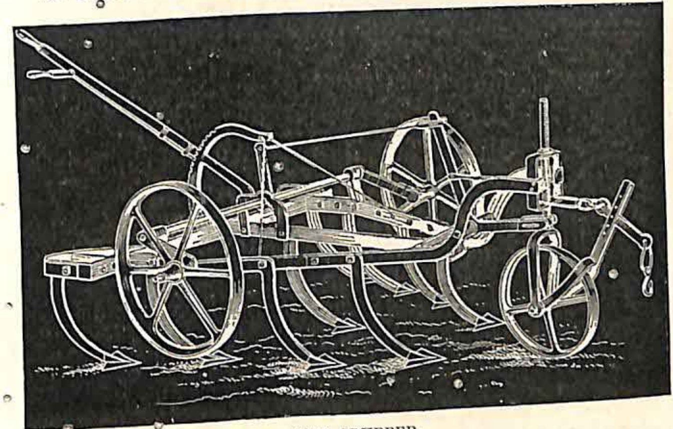
does it? He ploughs the land deeply, and **leaves the winter frost** to do the rest.

The ploughing turns up the soil, and **exposes the buried eggs and vermin to the killing effects of the frost. The frost is the farmer's best friend.**

4. *Turn next to consider the weeds—the farmer's other pest. Point out that the* **frost is powerless to kill these enemies.** *They are so hardy that the frost does them no harm.*

There is only one way to get rid of weeds, and that is **to root them up** completely, and **the plough alone cannot do this.** It would simply cut up the underground suckers of such weeds as **couch-grass,** and the tap-roots of others like **fool's parsley,** and this would **increase their growth.**

5. *Take the children to see* **the grubber** *or* **cultivator** *at work on a ploughed field, and let them examine the implement itself.*



THE GRUBBER.

It is something like **a zig-zag harrow,** but the **tines are longer,** and **curve forward,** so that they enter the soil obliquely to a depth of 5 or 6 inches, as the implement is drawn across the field.

These teeth, or tines, **catch and pull out completely all kinds of roots.**

*Call attention to the masses of weeds, that have been heaped up by this grubber at the side of the field.*

*Observe that when the grubber has worked the field thoroughly one way, it is* **drawn across at right angles to the first working,** *so that every part is gone over twice.*

The weeds that are missed one way, are pulled out when the grubber goes over the field the second time.

*Refer once more to the* **constant hoeing of the root crops** *throughout the growing season. This will make it clear to the class why such land* **does not need autumn cultivation.** It is **only corn-land** that is **thus treated.**

## IV. THRESHING

1. *This is another important operation, which the boys ought to see for themselves. Take them to the farm some day when the work is going on.*

A man stands on the rick, and feeds the machine with **loose stalks of corn,** as the boy beside him **cuts the bonds of the sheaves.** This man, who is called the **feeder,** simply passes the corn into a **hole** or **mouth at the top of the machine.**

The machine is worked by means of a leather band, which passes round one of its own wheels, and also round the fly-wheel of a steam-engine. All that can be seen is **the whirl of these revolving wheels.**

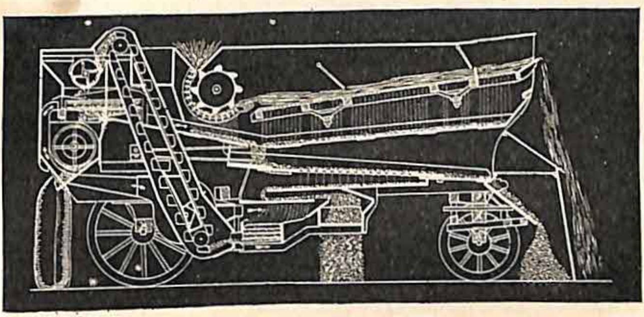
2. *Observe that the* **straw comes out at one end of the machine;** *the* **chaff** *or* **husk** *falls* **through the bottom;** *and the* **corn** *passes out* **at the other end into a hanging sack.** The whole of the work of separating the grain from the ears takes place inside the machine, and cannot be seen.

3. *The boys, of course, would be curious to know how the*

*work is done; but as it might not always be possible to examine the machine itself, there should be a good picture in the school for reference. Take the earliest opportunity of describing it.*

4. There is a **large perforated concave or riddle,** and inside this a **sort of drum, with flaps or beaters** round it, is **constantly revolving.**

The corn thrown in by the feeder passes into this



THE THRESHING MACHINE.

concave, and the **revolving beaters catch it,** as they whirl round, and **beat out the grain,** while the straw is carried along by a set of ladder-like frames, called the **shakers,** and discharged at the other end.

5. The grain falls from the shakers, and through the holes in the concave, **on a slanting sieve.** A constant current of air is kept up by revolving fans, and **this wind passes through the sieve** as the grain is falling on it, and so **blows away the chaff.**

An endless band, **to which cups are attached,** revolves on two wheels. As the cups move round, the mouth of each of them is **turned towards a sort of spout,** and the grain passes from the sieve, **by means of this spout,** into the cups.

It is carried by the cups to the top of the machine, and emptied by them as they revolve into the box or **hummeller.**

Here it meets another current of air, **which blows away the lighter chaff,** and the **grain** itself **falls from the hummeller** by means of another spout **into the sack.**

### SUMMARY OF THE LESSON

1. Swedes and turnips make excellent food for the sheep. They are usually fed on the land where they grow.

2. Mangels are stored either in houses, or in pits well thatched with straw to keep them from the frost.

3. Cow-cabbages provide a valuable food, at a time when green food for the cattle is scarce.

4. The grubber or cultivator is necessary to thoroughly clean the corn-lands, before they are laid up for the winter.

5. Threshing is an important part of the farmer's work in the late autumn and winter.

# THE FARMER'S PESTS AND FRIENDS

## Lesson XIV

## SNAILS AND SLUGS

The teacher will require a few good specimen snails and slugs, which of course the children will be glad to bring. In addition to these some young snails of various sizes, and some snails' eggs, should be provided. A snail and a slug should be placed on a wet sheet of glass, with a piece of cabbage leaf beside them, and then put aside in some dark corner till they are wanted. The teacher should also have, ready to hand, a snail's shell, which has been carefully sawn through lengthwise from the top of the spiral; Brown's pictures of the snail and slug; and a stocking, with a round button sewn to the tip of the toe.

### I. INTRODUCTION

1. *Show the specimens side by side. The children are, of course, quite familiar with these* **pests of the garden.** *Lead them now to tell all they can of them from their own*

*observation. A few carefully chosen questions will readily elicit such facts as the following:—*

2. Snails and slugs are **vegetable feeders.** They do an **immense amount of damage to the young tender plants and fruits** in the garden.

*Show some leaves which have been eaten by these creatures.*

We search for them and destroy them at every opportunity.

The best time to search for them is at night, for they are **creatures of the night**

They are **rarely seen abroad in the daytime,** except in damp weather, or after a shower of rain.

They hide away and **sleep all day** under leaves and stones, but **at night they come out to feed.**

3. As autumn advances, they either **bury themselves in the soil,** or hide away in some hole or crevice, and so **sleep through the winter.** They are **winter sleepers.**

We throw up the soil roughly for the winter, so that the frost may penetrate it and destroy them. (*The children's past experience will take them so far.*)

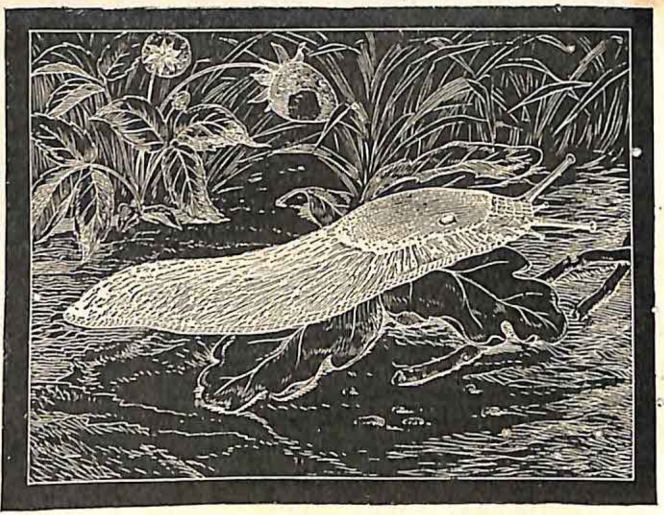
### II. STRUCTURE

*Proceed now to compare the structure of the two creatures.*

1. BODY.—*Notice in the first place that both have* **soft bodies**—*that there are* **no bones, no internal skeleton** *of any kind, and* **no limbs,** *such as we have found in all other animals which we have examined hitherto.*

**Snails and slugs are soft-bodied animals.**

2. *Point out that the snail has* **a shell**—*a sort of house into which it can retire for rest, or when any danger approaches; but* **the slug has no such protection for its soft body.**

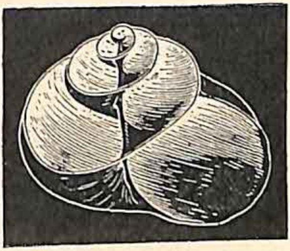


*Tell that slugs, as well as snails, begin life with a shell; but as they grow bigger their shell seems to disappear.*

The slug has nothing of its shell left but **a little**

**flat plate just under the skin,** where it forms a sort of **hump** on the back.

1. THE SNAIL'S SHELL.—*Let the children examine the shell.* **It is all in one piece.** We call such a shell **a univalve.** *Compare it with the shell of an oyster, which is in two pieces*—**a bi-valve.**



*Show the shell which has been sawn through lengthwise. Call attention to :—*

(*a*) **The central column,** *which runs through to the top of the shell ;*

(*b*) *The* **long tube,** *which coils round it* **cork-screw fashion** *from left to right.*

The shell in which the snail lives is really **a long coiled tube,** and of course when the body of the snail is in its shell, it must be coiled up too. **It fits the tube close.**

2. *Now show the specimen snails in various stages of growth. Point out that all the shells, even the smallest, are* **the same in form.** *If we could cut them through, we should find that they all have the same coiled tube.*

What will these tiny snails do in such a house, as their bodies grow bigger?

*Tell that* **the snail builds its house** *with materials, which it makes in its own body.* It is able to send out from its body **a watery fluid, which contains lime,** and hardens into shell as it dries. As its body grows bigger, **it builds its house bigger with this fluid.**

3. *Compare the little shells one with another, and with the large one, noticing that the older shells have more lines of growth round them than the smaller ones.* These lines show where the layers of new material have been added to the rim of the shell from time to time.

1. MANTLE.—*Point out the* **fleshy-looking hump** *on the fore part of the slug's back.* This shows the position of **the mantle.**

*Tell that the snail has* **a mantle** *too, but only the edge of it* —**the collar**—*is to be seen, for the rest is covered by the shell.*

The **mantle** itself is **a soft skin** or **covering for the body.**

It covers the whole of **the body,** when the snail retires inside the shell.

2. *Elicit that, when the snail moves, it thrusts its head and part of its body out of the shell, and it then carries its house on its back.*

*Explain, however, that the creature is in no danger of slipping out of its shell altogether.* **The body is fastened to the shell by the mantle.**

*Tell too that it is* **this mantle** *which* **prepares and pours out the chalky slime** *for building up the shell.*

1. BREATHING ORGANS.—*Point out the* **little slit** *in the mantle of the slug. It is on the right side near the edge.*

The **lungs are underneath the mantle,** and this little slit is the **breathing-hole,** through which air passes in and out of the lungs.

In the snail the lung-slit opens under the mouth of the shell, and is not so easily seen.

2. *Lead the children to tell that the purpose of breathing is the same in all animals*—air must enter the lungs to purify the blood.

*Note that the blood of the slug and the snail is* **cold** *and* **colourless**—*not red and warm like ours.*

Yet it must be purified with fresh air.

3. *Explain that* **the mantle is full of blood-vessels,** *and that when air passes in through the breathing slit, it is brought into close contact with the blood, and so the work is done. Notice that* **no boneless animal breathes through the mouth and nostrils** as we do.

1. HEAD, HORNS, AND EYES.—*Call attention to the peculiar form of the head, with its* **four soft horns**—*two long ones above, and two shorter ones below.*

The head and horns are alike in both creatures. **The eyes are at the ends of the two upper horns;** the **lower pair** of horns are simply **feelers,** answering to the whiskers of some other animals. *Elicit that* the eyes are placed at the ends of those long horns, to enable the creature to see in all directions.

2. *If one of the living specimens should be out of its shell, touch it, and observe how rapidly first the horns and then the head too disappear within the shell.*

*Explain how this is accomplished:* — The horns are **hollow tubes** with a muscle running up the middle. When this muscle contracts, **it pulls in the end of the horn,** and of course the eye with it, just as we draw the foot of a stocking within the leg. *Illustrate this. The button sewn to the toe of the stocking will of course represent the eye, and can be drawn within the leg.*

1. MOUTH AND FOOD.—The **upper jaw is horny,** and serves the purposes of **a broad cutting tooth.** The tongue is long and narrow, and its upper edge is furnished with **an immense number of teeth** all pointing backwards.

2. *The teeth are arranged in rows, and there are* **hundreds of rows on the surface of the tongue.** *The slug has upwards of* **20,000 teeth,** *and the snail almost as many.*

As the tongue moves backwards and forwards, **these teeth act like a rasp or a file.**

Such teeth are exactly suited to the work of rasping through the vegetable matter on which these creatures feed.

1. FOOT.—*Produce the two specimens on the piece of wet glass, and let the children look at the under side of the glass.*

That long oval **under side of the body,** which rests on the glass, is called **the foot.**

*Notice that it is the same in both creatures.*

It is **thick and muscular**; and it seems to **cling to the wet glass,** just as a boy's wet leather sucker clings to a stone.

2. *Let the children watch the movements of this sucker-like foot through the glass, as the creature glides slowly along.*

The movement begins by a contraction of the muscles, which makes the foot **pucker up in the middle.** Then the fore part of the foot stretches out, and **pulls the rest after it** with a gliding, wave-like motion.

3. *Notice that, as it moves,* **it leaves its trail of slime behind it** *on the glass.*

*Explain that snails and slugs cannot move on a dry surface.* **This slime** is poured out from the body **to assist their movements.**

### III. Habits and Life-History

*Proceed now to deduce from what has been taught, that the habits of these creatures are dependent on their structure.*

(*a*) They live on plants, **because their horny jaws and rasping tongue** are exactly suited for such food.

(*b*) They come out to feed only in wet weather, or on dewy nights, **because they are unable to move on a dry surface.** The slime which assists them in their movements has to be prepared in their own bodies. They would want more than they could make, if they went abroad in the dry, hot weather.

(*c*) They lie and sleep in their holes till the rain comes, and then they venture out in search of food.

*The gardener often spreads dry sawdust or bran round his choice plants to protect them from these pests. If they once get on the sawdust, they are unable to move, and are caught there as in a trap.*

Winter Sleepers.—The slug simply buries itself in the soil to get out of the way of the frost.

The snail finds a snug hole, and prepares itself for its winter sleep, by **retiring into its shell,** and **fastening up the door** of its house **with layers of the chalky slime,** of which the shell itself is made. It leaves a hole in this temporary door for breathing purposes, and there it sleeps through the winter, shut up secure from the cold.

Why are these creatures winter sleepers?

EGGS.—Slugs and snails produce their young from eggs. The eggs, which are like **small round beads,** are laid in the ground, and are often brought to light, when the soil is turned over in the work of digging during the early spring.

*Show the specimen eggs.*

They are **soft and jelly-like** in appearance, and are generally **stuck together by a sort of gummy substance.** They are hatched by the sun. The newly-hatched snail, with its tiny shell, looks like a little glass bead.

### SUMMARY OF THE LESSON

1. Snails and slugs are soft-bodied animals.
2. The snail's shell is all in one piece. It forms a long coiled tube.
3. The snail builds its shell with materials which it makes in its own body.
4. Its body is fastened to the shell by the mantle.
5. The lungs, or breathing organs, are under the mantle. They breathe through holes in the mantle—not through the mouth and nostrils, as most animals do.
6. The eyes are at the ends of the two long horns. They can be drawn in, just as we draw the foot of a stocking within the leg.
7. The teeth act like a rasp, or a file. The slug has 20,000 teeth.
8. The foot clings like a sucker. It cannot move on a dry surface.
9. Snails and slugs come from eggs, which look like small round beads.

## Lesson XV

## THE EARTH-WORM (THE FARMER'S FRIEND)

Brown's picture of the earth-worm, a few living specimens, and a good pocket lens, are all the apparatus the teacher will require.

### I. INTRODUCTION

1. *Commence by reminding the class that, our last lesson dealt with two of the most destructive pests, which infest our gardens*—the snail and the slug.

*Tell that to-day we are going to learn something about* **one of the best friends, which the gardener and the farmer have.**

2. *Show the specimen worms, and lead the children to tell what they remember of the usefulness of these creatures in the soil.*

How do worms benefit the soil? They burrow in the earth, and the tunnels which they make **open the way for the rain and the air.**

What good do the rain and the air do? They change **the dormant matter** of the soil into **active soluble matter** fit for plant-food.

The earth-worms were thus "**ploughers before the plough.**"

3. *Remind the children of the* **worm-casts,** *which are often to be seen on the grass and garden paths, especially after a shower of rain. Those little heaps of soil look themselves more* **like a mass of curled-up worms** *than anything else.*

*Elicit that the gardener does not like to see them on his lawn, and he rolls the grass to get rid of the disfigurement. Then explain that, in reality,* **these worm-casts do the grass an immense service.**

They consist of **good fresh soil,** which the worms bring up from below, and this forms **a splendid manure** to feed the growing grass.

The lowly earth-worm is **one of the most useful of all Nature's creatures.** Let us see what we can learn about it now.

## II. STRUCTURE

1. SHAPE.—*Examine one of the specimen worms. Point out that, like the snail and the slug, this animal has* **no bones, no internal skeleton** *of any kind, and* **no limbs.**

*Notice the peculiar form of the body*—**long, round,** *and* **pointed at both ends.**

*Let the children touch it, and note that it has* **a slimy, slippery feel.** This **slime** is continually **oozing out through the pores of the skin.**

2. *Watch its movements on the table.* As it moves, **its body stretches and contracts** in turn. It moves with **the same pointed end always forward.**

*The children will naturally infer from this that, the pointed end* **must be the head.** *Explain that* **it is the head;** *but point out that there is nothing else to tell us this, for it has* **neither eyes, nose, nor ears,** *and it appears at first sight to have no mouth.*

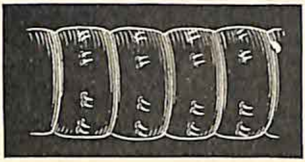
*Explain and show that in reality it has a mouth*—**a wide circular opening on the under side of the head.**

1. MADE UP OF RINGS.—*Call attention, in the next place, to the peculiar structure of the body.* It is made up of **a large number of narrow rings.** There are upwards of **120 of these rings** from the head to the tail.

2. *Let one of the class run his finger along the under side of the body from the tail towards the head, and tell what he observes.* **That part of the body feels rough,** and unlike the rest of the body, which is very smooth.

What does this mean? Let us see.

1. BRISTLE-FEET.—*Examine it with the help of a good pocket lens, and let the children discover for themselves* **the minute bristles—four pairs on each ring,** or segment, and **all pointing backwards.**



2. *Explain that the animal can instantly, and at pleasure,* **withdraw these bristles inside its body.**

These tiny bristles **serve instead of feet.** *Lead the children to reason out why they all turn backwards.*

## III. HABITS ADAPTED TO STRUCTURE

1. FITTED FOR BURROWING.—*From this examination and description the children will, with a little assistance, be easily able to show how beautifully Nature has fitted this creature for the life it is intended to live, and the work it is intended to do.*

It was meant to be **a burrowing animal.** That sharp pointed head enables it to force its way through the soil, with the least possible amount of labour. **Its head is its chief digging tool.**

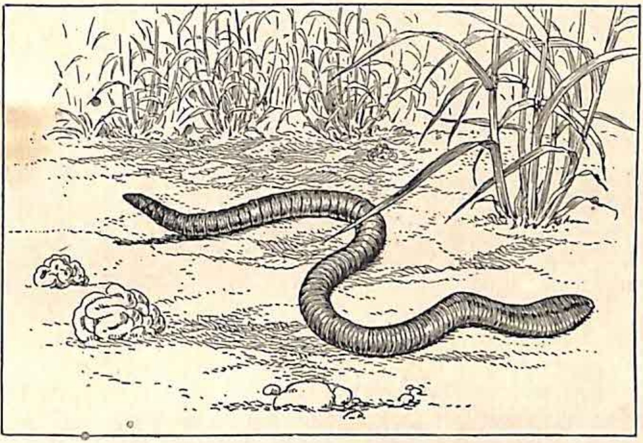
*Compare with the pointed head of the mole, and illustrate by calling upon one of the class to force a pencil into the mould in the flower-pot—first with the blunt end, and then with the sharp end.*

2. The smooth round body, without any limbs, can easily follow where the head digs. **Limbs would be in the way.**

The immense number of **bristle-feet** attached to rings, which contract and stretch at will, enable the creature **to lay hold,** and **pull itself along,** as it bores its way through the soil.

The **slimy coating on the body** prevents the soil from sticking to it, **keeps it slippery,** and so **helps it to glide through the tunnel** which the head bores.

3. *Point out that all this burrowing work could not be done without the help of strong muscles.* It is by means of these muscles that the body is able to contract and stretch at will.



*Explain the action of these muscles, as the creature bores its way through the earth.*

4. The worm commences its digging work by **forcing its pointed head into the soil,** and as this goes on, the bristles on the front rings **seize hold of the sides of the tunnel** thus made, while the hinder part of the body is **drawn forward by the contraction of the muscles** between the segments.

When these muscles contract, they make the front part of the body swell out, and **this enlarges the tunnel.**

As the body is drawn forward, **the bristles on the hinder part lay hold of the walls** of the tunnel, while the muscles of the front rings again contract, and force the head forward.

1. EYES, EARS, AND NOSE USELESS.—*Lead the class to*

*tell why to such an animal,* **eyes, nose,** *and* **ears** *would be* **worse than useless.**

Yet Nature provides even the earth-worm with **something to make up for these organs.**

2. *Ask the children to go out into the garden at night, and search for the worms, which always make their way up to the surface after dark. The moment a light is struck, they will see the worms dart back into their holes.* **They have no eyes,** but somehow they are **sensible of light without them.**

*It is exactly the same if we touch them, or make a sudden noise; they instantly withdraw into their holes.* They are sensitive to touch; and they can somehow **hear without the help of ears.**

3. Worms have **no breathing-holes,** like those of the slug and the snail; nor do they breathe through nostrils as most animals do. They seem to **breathe over the whole surface of the body.** Their blood is **red—not colourless,** like that of the snail. The blood of most boneless animals is either colourless, or of a greenish tint.

4. *Point out that, in a similar way,* **although they have no nose,** *they must have* **some sense of smell,** *for they always choose the same kind of food, and they have nothing but their sense of smell to guide them in this.*

### IV. FOOD

1. This leads us to talk about the food of the earth-worm next.

*Explain that* **it lives on the dead leaves** *and* **stalks of plants,** *and* **all sorts of decaying vegetable matter. It swallows earth,** *to get from it any such vegetable matter it may contain.*

2. The earth-worm has **no teeth,** and yet it manages

to **grind up its food without the help of teeth**. How is this brought about?

*Lead the children to think of the birds—another class of animals which have no teeth. Elicit that their food is* **ground small in the gizzard by the help of stones,** *which they pick up and swallow.*

*Tell that* **the earth-worm grinds up its food in the same way,** *by the help of stones which it swallows.*

3. That part of its food, **which it does not want,** is thrown off from its body, **in the form of worm-casts** on the surface of the soil, to make the **wonderful fertilising manure,** which we spoke of at the beginning of the lesson.

*It has been estimated that there are upwards of* **50,000 earth-worms to the acre of land,** *and that these little creatures bring up to the surface of the soil every year no less than* **ten tons of these worm-casts,** *which have passed through their bodies.*

## SUMMARY OF THE LESSON

1. The earth-worm is made for burrowing in the earth.
2. Its long rounded body is made up of rings.
3. There are 120 rings, and on the under side of the body there are 4 pairs of bristles on each ring.
4. The bristles serve as feet; they can be drawn inside the body at will.
5. The slimy fluid, which covers the body, helps it to glide along.
6. The earth-worm feeds on dead leaves and other vegetable matter.
7. It swallows earth to get from it what vegetable matter it contains.
8. It throws off this earth from its body again, in the form of worm-casts.

## Lesson XVI

## INSECTS

Provide for illustration a few specimens alive and dead, and Brown's picture of insects. A piece of india-rubber tubing, and some wire will also be required.

### I. INTRODUCTION

*COMMENCE by reminding the children that, in many of our earlier lessons, we have had a great deal to say about insects, and then proceed to elicit that :—*

(*a*) One insect, the bee, provides us with honey and wax.

(*b*) Most of the flowers depend upon insects to fertilise them, and enable their ovules to develop into perfect seeds.

(*c*) Insects are the chief food of many kinds of birds, as well as of bats, hedgehogs, and moles.

(*d*) In the winter, when there are no insects, such birds leave us for warmer lands, and animals like the bat and the hedgehog take their long winter sleep.

*Remind the class next that some insects, like the* **common house-fly** *and* **the gnat,** *are little better than an annoyance and a torment, and so lead up to the fact that,* **all insects are not useful to man,** as the bee is.

It is very necessary for us to know something of the insects, in order that we may be able to **distinguish friend from foe.**

### II. STRUCTURE

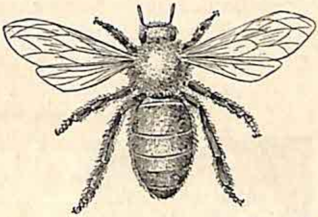
1. THE NAME—INSECT.—*Show the picture and the dead specimens now.*

*Call upon the class to name, as far as they can, each individual on the sheet, and on the card. Then ask for the* *general name*—**insect**—*which includes the whole of these little creatures. Write the word* **in-sect** *on the black-board.*

Let us see why we name all these creatures **insects.**

2. *Examine a dead specimen of one of the largest of those named—a bee will do as well as any.*

*Point out that it appears to be deeply* **cut across in two places,** *so that it is nearly separated into* **three distinct parts.**



The words **"in-sect"** mean **"cut into."** We name these creatures **insects,** because they are all **"cut into"** in this way.

The three natural divisions thus formed are the **head,** the **chest,** and the **body.**

1. Segments and Joints.—*Let the children handle one of the dead specimens now.* It **feels hard and horny** to the touch.

*Let them crush it between the finger and thumb.* There is **no internal skeleton.** There are **no bones** of any kind. It is only the horny outside case, which gives the little creature its shape. **Insects have an outside skeleton.**

*Examine this outside case carefully.* It consists of a number of **rings, or segments, of hardened skin.**

2. *Notice that* the segments are **not complete rings,** as they do not pass entirely round the body. Each segment is **in two parts**—an upper and an under half, joined at the sides by **a loose elastic skin.**

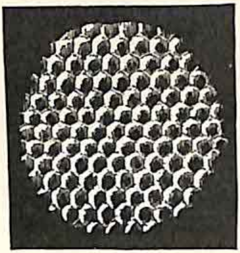
*Lead the class to tell that such an arrangement gives these creatures* **great freedom of movement.**

3. *Count the segments on the specimen bee.* There are thirteen in all—**nine in the body, or large hinder part, three in the chest,** and **one to form the head.**

*The segments cannot be so easily distinguished in all insects, as they can in the bee.*

1. THE HEAD.—*Proceed to examine the head next.* It is **all in one piece**—not made up of segments. It contains **the eyes, the feelers,** and **the mouth parts.**

*Tell that* **insects have no brain.** They have instead a number of knots of nerves in various parts of the body. The largest of these knots is in the head, and sends branches to the eyes.



2. **The eyes** are not single, like those of most other animals. Each eye is made up **of an immense number**[1] **of small eyes massed together.**

*Show in the picture, or by means of a black-board sketch; and compare this compound eye to a* **blackberry,** *or a* **raspberry.**

These wonderful eyes are usually placed **more at the side than the front,** and **stand out well from the head,** to enable the insect to see around it in all directions.

3. *Remind the class that* **insects have many enemies.** These prominent eyes, each made up perhaps of **thousands of very small eyes,** are intended as a means of protection, for they can **see behind them, above, below,** or **sideways, as well as in front.**

*Try to bring a stick, or the finger, near a common fly from behind, and note the result.* Why does it fly away?

4. **The Feelers.**—*Show that each insect has* **two feelers,** *one on each side of the head.*

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[1] In addition to these compound eyes, bees have three small eyes, called simple eyes, consisting of a single facet, placed in a triangle in front of the head. All insects, however, do not possess them; some like bees have three, others two, and others only one.

These feelers are not all the same shape and size, and **we do not know exactly the use of them,** although they are supposed to be **organs of feeling, smelling,** and **hearing.**

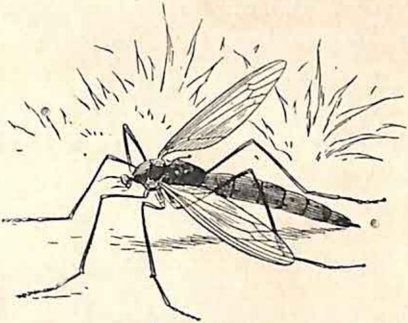
*Point out that they must be of great service, for* **the insect soon dies if it loses them.**

THE CHEST.—The chest is **the middle part between the head and the body.** Point it out. To it are joined the **wings** above, and the **legs** on the under part.

1. **The Wings.**—*Examine the wings of the specimen bee, and compare them with those of other insects in the picture, to show that insects have, generally speaking,* **two pairs of wings.**

*Explain that in some insects the second pair of wings are wanting; but we find* **a pair of balancers** *in place of them.*

2. *Show the* **daddy-long-legs** *and the* **gnat.** *Notice that these insects have only two wings, and that just behind each wing there is* **a slender sort of stalk,** *with* **a small rounded knob** *at the end of it.* These are the **balancers.**



If these little stalks get injured in any way, the insect seems to lose command over itself, and **flutter about almost helplessly.** It has been thought from this that, the probable use of the knobbed stalks is **to balance the body** during flight. Hence the name—**balancers.**

3. *Notice that the common* **house-fly** *appears,* **at first sight,** *to have* **only two wings.** *Show, and explain that it*

*has in reality* **a pair of very tiny wings just behind the large ones.**

They are not noticed till we look closely for them. They are useless for flight, but perhaps the fly uses them as balancers.

4. **Some** few **insects have no wings** at all—that is to say, none fitted for flight. They do not fly.

1. **The Legs.**—The legs are **six in number,** arranged in **three pairs.**

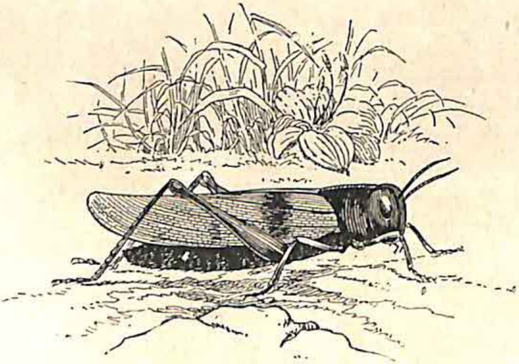
*Point these out in the picture, and in the specimens.* **Every insect has six legs.** *Call attention to the general structure* **—the long stout thigh, the leg,** *and* **the foot.**

Few things are more wonderful than the way in which the legs and feet of different insects are fitted to suit the particular kind of life, which each one leads.

2. *Show the grasshopper*—**the jumping insect.**

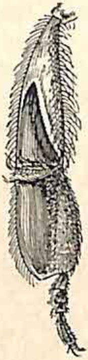
*Point out the* **long legs** *and* **strong thighs.** *Compare them with the legs of the beetle.*

These beetles were intended to be **burrowing insects.**



They too are provided with **strong legs** and **feet,** but in this case the legs and feet are specially fitted for digging, **not for leaping or jumping.**

3. The **bee's legs** are hollowed out to form a **sort of basket,** which is **edged round with stiff hairs.**



BEE'S LEG MAGNIFIED.

The bee makes use of this basket, **to carry home the pollen from the flowers** for feeding purposes.

1. THE BODY.—*Call attention to the* **big hinder part** *of the insect—the part next to the chest.*

This is **the body.** It contains the **organs of digestion** and **breathing.**

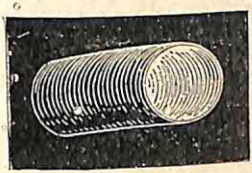
*Elicit from the class that, the purpose of all breathing is* **to purify the blood,** *by ventilating it with fresh air.*

*Tell that* **the blood of an insect is cold and colourless**—*not warm and red like ours; yet it must be ventilated with fresh air.* That is to say, **the creature must breathe.**

2. *Point out that* **insects have no lungs** *such as we have, and so rouse the curiosity of the class to learn how they manage to breathe without lungs.*

*Tell that a careful examination with the magnifying glass shows us* **a number of small holes, in the loose elastic skin,** between the upper and lower segments of the body.

*Explain that these are* **the insect's air-holes,** or **breathing-holes.** It breathes air into its body through these holes, **just as we take in air through our two nostrils.**



3. The holes are **the ends of fine tubes,** which lead into **two larger ones** running through the whole length of the body. The **two main canals** send off **smaller and smaller branches** in every direction, and so the insect is able to **breathe air into every corner of its body.**

The work of blood-purifying is always going on all over the body, and not in one part, as it is in animals which have lungs.

4. *Point out that if the air is to get freely into every part of the body of the insect,* **these tubes must be kept open**—*there must be no chance of their falling together, or closing up.*

*Make a sketch on the black-board, to show how this is provided for by means of* **an elastic coiled spring,** *which lines the inside of every tube.*

5. *Make a coil of wire, and force it inside a piece of rubber tubing, to illustrate this further.* The tubing collapses, without the coil, if it is pressed. The coil keeps it open, no matter how much it is squeezed.

*Elicit that this free passage of air into every corner of the insect's body, besides purifying the blood,* **renders the body very light,** *and so fits the creature for its life in the air.*

*Compare this with the arrangement for the circulation of air in the bodies of birds.*

### III. Food and Habits

1. *Lead the children to tell, from their own observation, that* **one insect feeds on solid vegetable matter,** *and* **another lives by sucking the juices of flowers.**

*Point out that with insects, as with all other creatures, the kind of food, which each one is intended to eat,* **depends entirely on the form of the mouth.** *Hence it is clear that* the structure of the mouth is **not the same in all insects.**

2. *Explain that all those, which are intended to live on solid food, are provided with* **strong jaws for biting and chewing.** The jaws of some are made **like the edge of a saw,** for sawing through their food.

*Point out that all such insects are alike in one respect.* **Both jaws move**; and they **always move sideways**—never up and down. In most other animals it is **only**

**the lower jaw that moves**; and it moves **up and down.**

3. *Tell that these insects do not all live on vegetable matter, for some of them, like* **the tiger beetle, devour other insects.** This little creature is as **fierce as a tiger,** and is provided with **powerful jaws,** or mandibles, **for tearing its victims to pieces.**

### SUMMARY OF THE LESSON

1. The name **insect** means **cut into.** The body of an insect consists of three parts.
2. Insects have no bony skeleton. They are made up of rings or segments.
3. The head is all in one piece. Each eye is a mass of tiny eyes.
4. The wings and legs are joined to the chest.
5. All insects have six legs. Most of them have two pairs of wings.
6. Insects have no lungs. They breathe through holes in the skin of the body.
7. Some insects feed on solid food. They have jaws for chewing, but the jaws always move from side to side.

## Lesson XVII

## INSECTS—THEIR LIFE-HISTORY

The teacher will require some birds' eggs, and specimens of insects' eggs; a few caterpillars, maggots, and other grubs; a collection of pupa forms; and Brown's picture of Insects.

### I. INTRODUCTION

1. *PRODUCE the birds' eggs, and proceed at once to elicit all that the class can tell about them, as follows:—*

The mother bird **lays the eggs in a nest,** which has been specially prepared for them.

She **sits on them to keep them warm,** warmth being necessary to hatch them.

2. When they are hatched, young birds, **exactly like their parents in shape and make,** come out of them.

The parent birds **take every care of their young ones, and feed them with proper food,** till they are big enough to seek their own living.

3. *Tell that* **insects,** *like birds,* **produce their young from eggs.** *Show some of the specimens of insect eggs, and explain that each one, small as it is,* **contains a yolk and a white part,** *corresponding to what we see in the hen's egg. The mother insect lays scores, and often hundreds of eggs.*

To-day we are going to learn something about these eggs, and the young ones which come from them when they are hatched.

### II. THE EGGS

1. *Remind the children that* **the blood of insects is cold.** Hence they **cannot hatch their eggs with warmth from their own bodies,** for those bodies are cold too. **They leave the eggs, just where they lay them, to take care of themselves.**

2. *Contrast this with the anxious care shown by birds and almost all other animals in attending*[1] *to the wants of their helpless young ones; and then proceed to show that the mother insect, on her part,* **is not so wanting in anxious care for her progeny,** *as at first sight she appears to be.*

Many insects **die soon after laying their eggs.** Many more of them die long before the eggs can be hatched.

*Remind the class that eggs laid in the autumn cannot be hatched till the winter cold is passed, and the warm sun begins*

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[1] Bees, wasps, and ants are an exception to the rule, for they actually feed the young ones which come from the eggs.

*to assert its power once more, and that then the plants, on which the young ones are to feed, come into leaf.*

3. *Tell that even if the mother insect lived, she could not feed her young ones, for* **they rarely eat the same food as their parents.**

*Point out that* instinct seems to tell her that, her helpless young ones will begin life without a mother to care for them and feed them. Hence **she provides for them before she dies.** She always lays her eggs where the young ones will find, as soon as they are hatched, **abundance of the very food they require.**

1. FOOD FOR THE YOUNG.—*This will naturally rouse the curiosity of the children to learn where these insects lay their eggs.*

*Tell that* **the young of some insects feed on vegetable matter.**

In all such cases instinct usually leads the mother insect to deposit her eggs in some part or other of the growing plant—**in the root, the stem, the buds,** and **the leaves; in the flowers, the fruit,** and **the seeds;** and **in the bark of trees.**

But some mothers select **decaying vegetable matter** of various kinds, and some choose **rotten wood,** as the food-store for their future family.

2. *Point out that, strange as it may appear, there are others which would turn away from such food. They were meant to be* **flesh-eaters.** *From the moment they come out of the shell,* **they devour animal matter** *of some kind—fresh, dried, or putrid.*

The parents of these deposit the eggs **on both raw and cooked meat; on cheese; on the skin of living animals,** and **in the decaying bodies of dead ones; in bones, skins,** and **fur; in manure heaps,** and **in the ground.**

Whatever the place may be, it is chosen by the parent to secure **safety, comfort,** and **abundance of food** for the young ones she will never see.

1. THE EGG-DEPOSITOR.—*Enumerate once more some of the strange places chosen by various insects, in which to deposit their eggs; and then proceed to show how* **Nature has provided each one with tools,** *exactly suited to the work to be done.*

Every female insect is provided, at the extremity of the body, with a contrivance, known as **the egg-depositor**; but it varies in form according to the purpose for which it is required.

2. In some instances the tool is **a sort of auger** or **borer,** and is used **for boring holes** in which to deposit the eggs. In others the borer itself is **a hollow tube,** and the egg passes down the tube into the hole it makes. In another the insect is provided with **a pair of actual saws,** with which she **saws a slit** in the tender shoot of the plant to receive each egg.

### III. THE LARVA, OR GRUB STAGE

1. *Picture the egg resting in its snug secure hiding-place, till the time comes for it to be hatched, and the young creature crawls out of the shell.* The mother certainly would not take it for her child, when it makes its first appearance.

2. *Show in illustration of this:—*

(*a*) *A caterpillar, with its long body, a head, six legs, and a number of fleshy feet.* This is **the young** of some **beautiful moth** or **butterfly.**

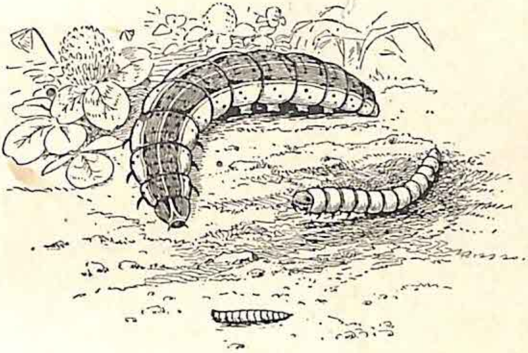
(*b*) *A maggot, without either limbs or head.* This came **from the egg of a fly.**

(*c*) *A grub, with a head and usually six legs.* The parent of this was **a beetle.**

3. These ugly crawling things are in no way like the parent insects.

We call the creature which crawls out from the egg the **Larva,** or **Grub.**

These larvæ of the insects are **hungry feeders.** Eating seems to be their one business in life. **In twenty-four hours they often eat more than twice their own weight of food.**



1. Destructive Pests.—*Explain that, it is mostly* **during this larva stage** *that, insects* **work such havoc with the farmer's crops,** *and* **the gardener's plants.** They devour everything before them. They sometimes destroy whole crops.

*Refer to the maggots in the peas, and the caterpillars on the cabbages in the garden.*

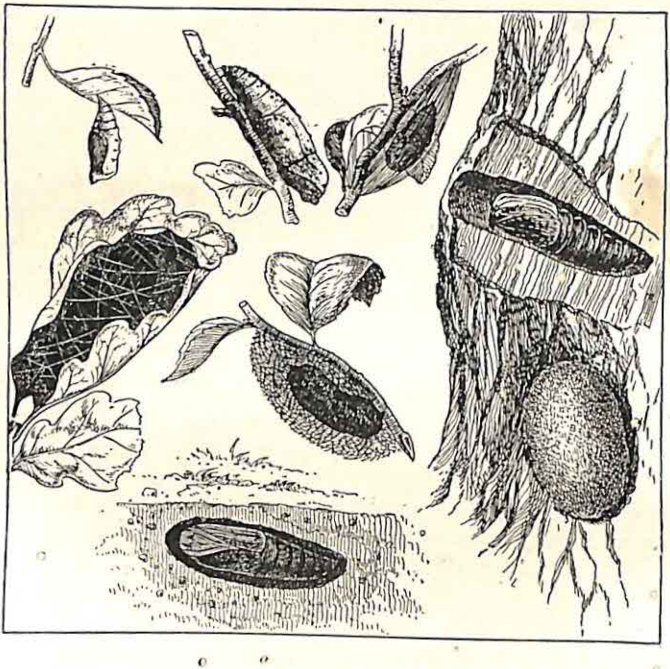
2. *Lead the children to deduce that, as the little creatures feed so greedily,* **they must grow very rapidly.** *Tell that, as they grow, their* **skin becomes stretched and stretched,** *till at last it splits, and* **then they hide away somewhere out of sight,** *and* **cast it off.**

They moult in this way **five or six times,** but they do not change the larva stage **till they are full grown.**

In some insects the larva stage lasts for **a few weeks** or **months,** in others for **one, two,** or **three years,** and all this time they are **feeding and growing.**

### IV. THE PUPA OR BABY STAGE

1. *Show the specimen pupa forms, which were collected for the lesson, and let the class examine them. Tell where they were found*—**one hanging by a sort of silky thread from a leaf or a twig**; another **enclosed in a loosely-spun**



**covering, and gummed to the leaf itself**; another **in the bark of a tree**, another **underground**, and so on.

*Explain that inside each of them is* **a living creature—the larva in a new stage of existence.**

It remained in the larva stage, **till the period of feasting and growing was at an end,** and the skin all over its body was stretched tight to bursting. Then it retired once more, and prepared to **change its skin for the last time.**

2. *Observe from what has already been said that, each individual selects its own special mode of retirement. But they all hide away out of sight, so that they may* **undress and sleep in privacy.** *Compare with ourselves at bedtime.*

3. While the creature is in this stage, it not only changes its skin for the last time, but **it takes an entirely new form.** Limbs begin to make their appearance, although they are *as a rule* **packed** or **bound close to the body** by an outer skin, just as in old times mothers **used to wrap their babies** in swaddling clothes.

Hence this is known as **the pupa**, or **baby stage.** *Explain that the change is going on now inside each of those cases on the table.*

4. *Observe that in each case* **the pupa lies helpless.**[1] *It* **neither moves nor eats.**

*Compare with the sleep of the* **winter-sleeping animals.** They feel no hunger while they lie sleeping; neither do the helpless creatures in these cases.

5. When at last the change is complete, **an entirely new creature** will emerge from the case.

It will have nothing of the larva or grub about it, but will be **a perfect insect,** with **every part of its body fully formed,** except the wings, which are often short and limp, but they quickly dry, and expand to their full size.

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[1] The earwig and the cockroach are exceptions to this. In each case the pupa has its legs free, and is able to move about and feed, while the change is going on. Such insects alter their shape during the change less than others, and the pupa may often be known by its possessing rudimentary wings, or wing-cases.

Another very curious fact in connection with the cockroach is that the mother insect lays her eggs, sixteen in number, arranged in two rows, inside a small case, and for some time before the eggs are deposited, she carries this case about with her at the tail end of her body.

### V. THE PERFECT INSECT

*The teacher should lay special stress on the following points :—*

1. INSECTS NEVER GROW.—As they leave the pupa case, in their perfect form, so they remain. **All the growing took place** while they were **in the larva,** or **grub stage.**

*Let it be clearly understood that,* **little flies do not grow into great blue-bottles, little beetles into big ones, gnats into daddy-long-legs.**

2. The perfect insect, as a rule, does not feed **on the same food** as it eats in the grub stage, although there are many exceptions to this.

*Compare the butterfly with its greedy children—the caterpillars.*

The caterpillar, from the very first, **devours everything before it** in the way of such **green vegetable food** as is suitable for it, and it is provided with **sharp strong jaws** for this very mode of feeding.

*Explain that all caterpillars* **do not feed on the same plants.** *Thus we should never find the caterpillar of the white cabbage-butterfly on an oak or an apple tree.* **It would die if we tried to feed it on such food.**

The mother insect lived by **sipping the sweet dainty nectar** from the cups of the flowers, and when it reaches its perfect form, as a butterfly, it will do the same. **It will have no jaws then,** but **a long trunk** instead **for sucking up those juices.**

3. Many perfect insects live but a very short time. They have **no other business in life but to lay their eggs,** and when that is done they die.

4. The life of some insects is so short that **they do not**

**need to feed at all.** They make their appearance in the perfect form, lay their eggs, and die almost at once.

### SUMMARY OF THE LESSON

1. Insects are hatched from eggs.

2. The mother insect lays her eggs where the young ones will find plenty of food.

3. She is provided with a contrivance, known as the egg-depositor.

4. The young one which comes from the egg is called a larva or grub.

5. It feeds till it is full grown, and changes its skin several times.

6. It is mostly in the grub stage that insects devour the growing plants.

7. When they are full grown they change into the pupa stage.

8. The new creature that comes from the pupa case is the perfect insect.

9. Insects never grow after leaving the pupa case.

## Lesson XVIII

## INSECTS WITH WING-CASES

The teacher should be provided with Brown's picture of "Beetles," and a collection of specimens, alive and dead, for illustration. If possible, a piece of worm-eaten elm should be obtained for the lesson.

### I. BEETLES

1. *SHOW the specimens, or failing them, the picture. The children will at once recognise these insects as beetles.*

*Call attention to the* **large powerful jaws** *of some of them, such as the stag-beetle and the tiger-beetle. Refer to the former lesson, and lead the children to tell that,* **insects which have jaws** *are all intended to* **live on solid food.**

2. *Tell that* **all beetles have a strong pair of jaws** for biting off their food, and **another pair of jaws** for chewing it.

*Elicit further that in every case* **the jaws move sideways**—*not up and down.*

*Let the children next examine one of the dead specimens, with the view of leading up to an inspection of the wing-cases.* **Beetles are known by their wing-cases.**

3. *Elicit that this class of insects* use only the second or **hinder pair of wings for flight.** The first or **outer pair** are **hard** and **horny**; they fold together like a pair of shutters, **to protect the second pair,** when they are not being used for flight.

4. *Lead the children to tell what they can of the habits of these insects, and deduce from that the reason, why they always have a hard horny case or shell, to cover up the true wings.* They are **burrowing insects**; their burrowing work **would damage the delicate flight-wings,** if they were not protected with this outer shell. We say beetles are **shield-winged insects.**

5. *Point out that the* hinder, or flight-wings, are much **larger than the outer pair.**

*Notice that they are* not stiff and hard. They are **very soft and delicate**; they can be easily **folded up and packed away** under the outer shutters, when they are not wanted.

## II. BEETLE, EARWIG, AND COCKROACH

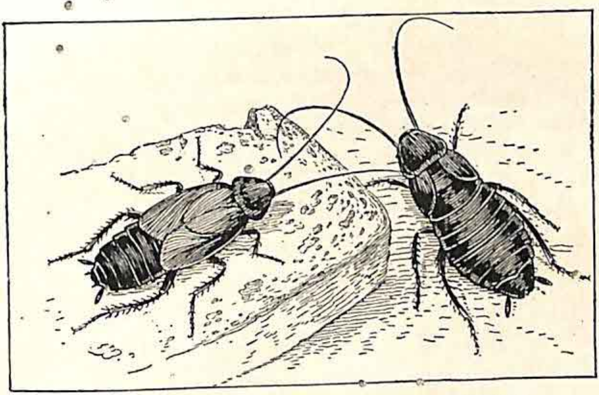
1. THE EARWIG.—*Call attention to the* **earwig** *in the picture. Notice that, like the beetles, it has* **two pairs of wings**—*one pair for flight, the others as* **shields** *or* **folding shutters,** *to protect them when not in use. It is difficult to see the flight-wings in an actual specimen, as* **earwigs rarely fly except at night.**

*Compare these wing-cases with those of the beetle. In the beetle the wing-cases form a horny shield,* **which covers the whole body. Those of the earwig are soft and small.**

2. *Elicit that those* large flight-wings could not be completely covered by the small cases, **unless they were folded up most carefully.**

Earwigs (earwings), although very much like the beetle, are **not true beetles.** They form a class by themselves; their **small soft wing-cases** and their **beautifully-folded wings** make them distinct from all other insects.

1. The Cockroach.—*Show the cockroach next—a specimen if possible; but when that cannot be obtained the picture must suffice. The children will of course recognise it by its more familiar name*—**black-beetle.**



MALE COCKROACH FEMALE.

2. *Proceed to examine it, taking first* **the male,** *then* **the female insect.**

*Point out, in the first place, that it is* **only the male** *which has* **two pair of wings.**

**The female of the common cockroach has no**

**flight-wings,**[1] and only **a small pair of wing-cases** partly covering the middle section of the body. **The female cockroach is not like the true beetles.**

3. *Show next that, even in the male, which is something like a true beetle, the* wing-cases do not fold together straight down the back—they **overlap one another**; and **the hinder or flight-wings fold up lengthwise something like a fan.**

*Tell that the* **cricket** *and the* **grasshopper** *have the same sort of* **straight-folding wings.** *Show these in the picture.*

4. The cockroach, grasshopper, and cricket all have wing-cases; but they are distinct from the beetles. They belong to a class of insects, known as **straight-winged insects.** The black-beetle is badly named; **it is not a beetle at all**; and further, it is **not even black.** Its colour is a sort of **mahogany-red.**

5. *In Lesson XVII. it was mentioned that, during the pupa stage the earwig and the cockroach do not lie in an apparently dead helpless state, as most insects do during the great change. Remind the class of this now.*

Both of them **have legs outside the pupa**; they **run about and feed,** just like the perfect insect. **The parent earwig,** too, unlike most insects, **takes great care of its young.**

## III. BEETLES AS BURROWING INSECTS

*It will be interesting now to notice the mining operations of some of these burrowing insects.*

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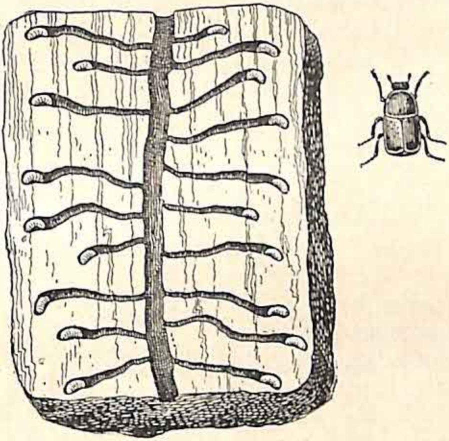
[1] There are a great many kinds of cockroaches, although only a few are found in this country. In some of them both the male and female have perfect wings, but in a few the wings are either altogether absent or rudimentary, not only in the female but in the male as well.

Some of them burrow **into the trunks of trees,** others **into the earth.**

*Take the* **little bark-boring elm-beetle** *as an example of the former class, and the* **mole-cricket** *to represent the latter.*

1. The Elm-Beetle.—*Show a piece of elm wood, which has been mined by this little insect, and call attention to the numerous* **channels,** *which spread through the wood* **in almost every direction from the main one.** They remind us of **a river and its tributaries,** as we see them drawn on a map.



*Tell that this tunnelling is* **the work of a small beetle,** *not more than a quarter of an inch in length.* It has no English name, so for want of a better, we call it **the boring[1] elm-beetle.**

2. The female beetle comes to maturity in July, and then she sets about the principal business of her life—**laying her eggs.**

She settles on the tree (an elm is the one always chosen), and **eats her way through the bark,** till she comes to the **soft wood beneath.** As she mines and tunnels through the inner bark and wood, she **deposits a row of eggs** on either side of the channel she has made.

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[1] Scientifically known as "Scolytus Destructor."

3. Having laid her last egg, her life-work is at an end, and she makes no effort to return to the outer world, but **curls herself up in some corner to die**; and there the dead body of the devoted mother is afterwards found.

In about two months **the eggs are hatched,** and the tiny grubs which come from them, at once begin to **feed on the bark and soft wood** of the tree, each one starting on its own account.

The result is that, from this one channel made by the mother, **an immense number of smaller passages are bored** in every direction by the children. The grub grows as it feeds, and of course **makes its tunnels larger and larger,** to accommodate itself as time goes on.

4. When it is full grown, it changes **first to a chrysalis,** then to **a perfect beetle,** and in that stage, **it gnaws its way to the outside,** where in course of time it lays the foundation for another colony of miners.

In this way, **generation after generation of these boring beetles** eat their way into the tree, till at last **it falls into decay** and perishes. Whole avenues of elms have been destroyed by the work of this mining insect.

1. THE MOLE-CRICKET.—*Point out the insect in the picture, and remind the class that this is* **an earth-miner.** *Tell that it gets its name*—**mole-cricket**—*because in its habits of life it has* **a strong resemblance to the mole.**

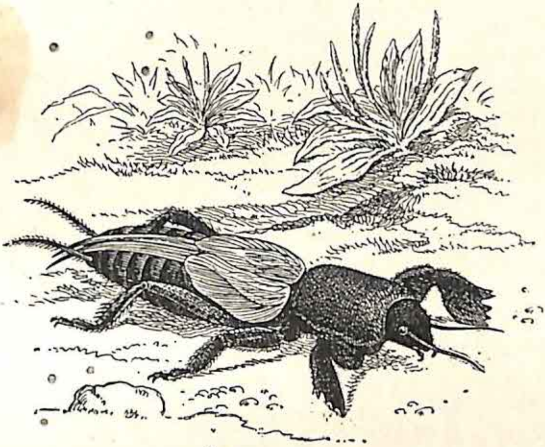
*Notice that* **the legs are short, stout, and strong,** *and the* **feet turn outwards,** *and are like* **flat paws.**

*Compare these feet with the paws of the mole itself.* **They are the digging tools.**

2. *Refer once more to the mining work of the* **elm-beetle.**

That insect eats its way into the tree, **to provide a home and a food-store for its young ones,** when they come from the eggs, which she is about to lay.

*Tell that*, **the mole-cricket,** *on the other hand*, **lives in the underground tunnels** *which it makes, although it comes up above ground sometimes*, **to fly abroad in the evening.**



It actually constructs a home for itself underground, **just as the mole does,** and like the mole **it feeds on grubs, insects,** and **worms,** which it finds there.

## SUMMARY OF THE LESSON

1. Beetles are known by their wing-cases.

2. They are burrowing insects; the wing-cases are meant to protect their delicate flight-wings during their mining work.

3. They use their hinder wings in flight.

4. The earwig and cockroach are not true beetles. These insects in their pupa stage have legs, and run about.

5. Some insects, like the elm-boring beetle, burrow into the trunks of trees; others, like the mole-cricket, burrow in the ground.

## Lesson XIX

## BEETLES—FRIENDS AND FOES

Brown's picture of "Beetles" should be provided for illustration.

### I. INTRODUCTION

*COMMENCE by running rapidly over the subject of the last lesson, so as to refresh the memory, and lead the children to tell the chief characteristics of this family of insects*—their **burrowing habits,** their **wing-cases,** and so on.

*Tell that the beetles form* **the largest family in the insect world.** Upwards of 120,000 different kinds are known to naturalists, and these are certainly only a very small number of the entire beetle family. Some of them are **flesh-eaters**; some live on **vegetable food.** Some we may reckon amongst **our friends**; others are a **pest,** and often **a scourge to man.**

It therefore becomes a matter of importance to be able to tell friend from foe. Let us examine a few of them now.

### II. FOES

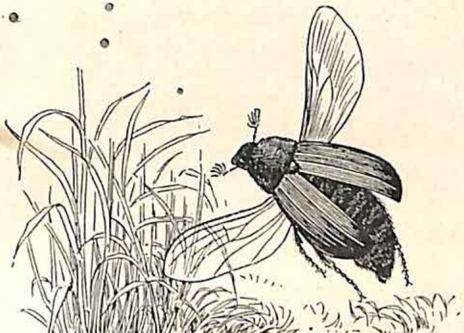
1. THE COCKCHAFER.—*Point it out in the picture, and tell that this is* **one of the farmer's worst foes.** *Show also the larva of the insect.*

**During the grub stage** it lives underground, for the mother insect lays her eggs in the ground. It spends three years in the ground as a grub, and **feeds voraciously on the roots of plants,** using its **sharp sickle-like jaws** to cut its way into them.

When it attacks the roots of the grass in the meadows, **it causes the grass itself to wither and curl up,** and become dry like hay.

2. When full grown it changes into the pupa form, but although the final change into a perfect insect takes place in the autumn, it does not leave its hole in the ground till the following spring.

After emerging in its perfect state **it becomes no less**



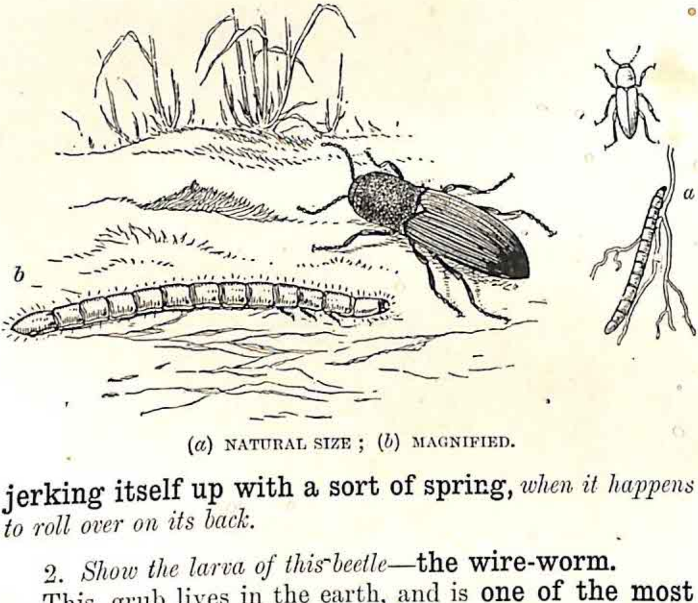
**a scourge,** for it then attacks the trees. These insects have been known to swarm in such vast numbers, and to carry on their ravages to such an extent, as **to destroy all the trees in a wood.**

3. *Explain that luckily the farmer has friends as well as foes.*

**Thrushes, blackbirds, and rooks are very fond of the grub** of this insect. These birds may often be seen pulling the grubs up out of the ground. Then too the **nightjar,** and a few other birds later on, **seem to come specially for the cockchafer itself.** They do not leave us while there are any to be found.

All such birds are most useful in destroying these pests. Therefore, if you kill these birds, or take their eggs or young ones, you are really doing a very serious injury to the farmer.

1. THE SKIPJACK BEETLE.—*Show this in the picture. Most country boys are familiar with it, from* **its habit of jerking itself up with a sort of spring,** *when it happens to roll over on its back.*



(*a*) NATURAL SIZE ; (*b*) MAGNIFIED.

2. *Show the larva of this beetle*—**the wire-worm.**

This grub lives in the earth, and is **one of the most destructive foes** of the farmer and gardener. It **feeds on the roots** and underground stems **of plants,** and has been known to destroy whole fields of corn, turnips, cabbages, and peas.

3. The grub itself is about a **quarter of an inch** in length; its body is a **bright yellow colour,** and is covered with **short bristles.**

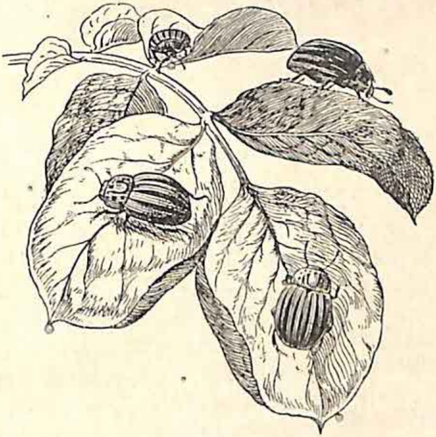
The perfect insect (**Skipjack beetle**) emerges from the pupa stage in June, and from that time it becomes a scourge to flowers, and to the leaves of certain shrubs.

There are several different kinds of skipjack beetles, and of the wire-worms which produce them; but they are all very similar in their habits.

4. *Tell that in the garden the wire-worm may be exterminated by* **planting young lettuces** *to act* **as traps.** *The lettuces will quickly begin to wither under the attack of these pests, and they should then be* **rooted up and burned.**

Another, and perhaps a better plan is to **bury pieces of raw potato and carrot** a few inches deep in the soil. They make capital traps; they can be **dug up every day,** and the **wire-worms about them destroyed.**

1. THE COLORADO BEETLE.—*Show this in the picture, and tell its other name*—**the Potato beetle.**



*Explain that it is so called, because both* the larva and the perfect insect **live on the potato.** It is looked upon as **one of the most destructive** of these insect pests.

It is a tiny thing, from one-third to half-an-inch long, yellow in colour, with ten long black lines down the wing-cases, and orange-and-black legs.

This beetle **burrows in the earth as winter approaches,** and comes up above ground in May to lay its eggs. The mother insect lays from 700 to 1200 eggs.

2. She deposits them, **from a dozen to twenty in a group,** on the under side of the **potato leaf,** and in three weeks the perfect insects have passed through all their stages.

These **at once produce more eggs,** and so the pest increases, till the whole potato crop is destroyed.

3. *Tell that in our country we are free from this fearful pest, but as there is always some danger of its being accidentally introduced from America, it is well to know what it looks like, so that it may be recognised and destroyed before it has time to get a footing.*[1] *The only way of stamping it out is* **by destroying every egg, and every larva,** *as it appears.*

1. THE WEEVILS.—*Point out these tiny beetles on the picture. They are easily distinguished by the extraordinary* **length of the snout.**

There are several members of this destructive family,

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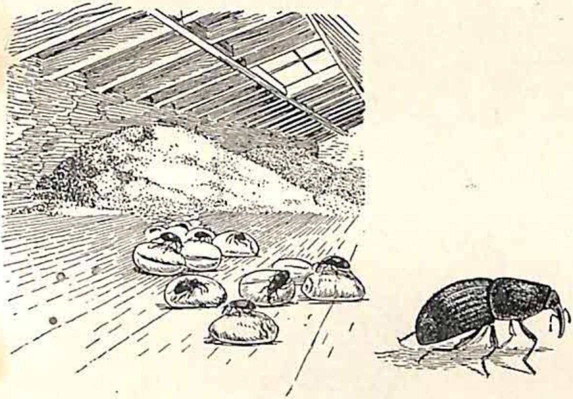
[1] The beetle was first brought over here in 1877 from Colorado in America, and luckily for us the pest was stamped out in time.

During the last days of August this year (1901), some men employed by the Tilbury Dock Company found that a patch of potatoes on their allotment ground in that neighbourhood was infested by a strange kind of beetle. They reported this at once, and the beetle was found to be none other than the terrible scourge—the Colorado beetle. Of course the whole of the potato crops on these allotments and every vestige of grass all round had to be destroyed immediately; but, thanks to the vigilance of the authorities, what might have been a fearful visitation ended in a few days' scare.

*e.g.* **the corn-weevil, the nut-weevil,** and the **apple-weevil.**

2. The corn-weevil is **the pest of the granary.** It passes the winter in some crack or cranny in the wall of this building, and lays its eggs in the grains of corn, **boring a hole for one egg in each grain.**



It is a most destructive pest, for **the beetles as well as their grubs feed on the stored corn.**

*Tell that a good farmer never stores his grain long enough to have it destroyed by this beetle. He sends it to the miller as early as he can after threshing.*

**Inverted pots are sometimes used as traps to catch these beetles.**

3. The **apple-weevil** and the **nut-weevil** are equally destructive. The apple-weevil makes a hole in the **swelling flower-bud** in early spring, and lays its eggs there—**one egg in each hole.**

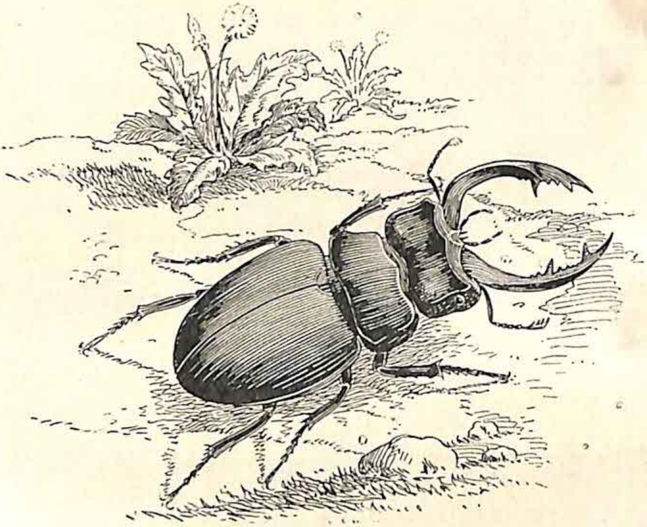
The grub feeds on the inner parts of the flower before it opens, and thus **destroys the ovary entirely.**

The gardener gets rid of this pest by **painting the**

**trunk and branches of the tree** with some substance, which is poisonous to the insect without being hurtful to the tree.

1. The Stag-Beetle.—This is **the largest beetle found in our country.**

*Point it out in the picture, calling attention to* **the enormous jaws of the male insect,** *which look like* **a pair of stag's antlers.** *Hence its name.*



*From the appearance of these formidable jaws, the children will of course expect to find this beetle one of the fierce predatory kind. Explain that it is not so.*

2. The stag-beetle **lives on the sap of trees**; it uses its jaws **to make holes in the bark,** so as to cause the sap to flow. **The larva of the insect feeds on the wood of trees.**

It is therefore destructive to the trees which it haunts.

## III. FRIENDS

*After dealing in this way with one or all of these destructive beetles and their grubs, it will be an easy matter to rouse the curiosity of the children, to learn in what way other beetles can be looked upon as friends.*

*Remind them that some beetles devour other insects. They are as much our friends as the birds, bats, and other creatures that feed on insects, for they act as a check on the too rapid increase of these pests.*

*Take as examples :—*

1. THE TIGER-BEETLE.—*Point out this one in the picture, noting the beautiful* **green and gold sheen of its wing-cases.**

It is **one of the most beautiful** of the family, and at the same time **one of the fiercest.** It well deserves its name—**tiger-beetle,**—for although only **about half an inch long,** it is **as fierce as it is beautiful.**

2. It is a **veritable tiger in the insect world,** and with its powerful jaws, as **sharp as reapers' sickles,** is as much **dreaded by the creatures around it, as the tiger is among beasts.**

It **runs with such rapidity** that, the eye can scarcely follow it ; and in a twinkling it can raise itself on its wings, and **fly with equal ease and speed.**

3. However, as it kills and devours insects, that would be hurtful to our plants, **we can reckon the tiger-beetle amongst our friends.** Even in the larva stage it is a terror to other insects, for it darts upon them as they

pass, and **drags them into its burrow to devour them.**

THE LADY-BIRD.—*The children are, of course, quite familiar with this little insect.* It may take rank as one of our friends.

*Tell that the* **larva** of the lady-bird feeds on the **blight,** or **green fly** (aphides), which sometimes infest the plants and shrubs in the garden, as well as the farmer's corn, fruit, and hops.

The mother insect always lays her eggs on plants where these destructive pests swarm, so as to ensure a plentiful supply of food for her young grubs, when they are hatched.

### SUMMARY OF THE LESSON

1. The cockchafer, both as a grub and a perfect insect, is one of the farmer's worst pests.

2. The wire-worm is the larva of the skipjack beetle. It is a terrible scourge: it destroys the roots of plants.

3. The Colorado beetle is one of the most destructive of all the insect pests. It attacks the potato.

4. The weevils do much damage to corn, nuts, and fruit.

5. The stag-beetle is the largest of our British beetles. It feeds on the sap of trees, and uses its jaws for cutting through the bark.

6. The tiger-beetle kills and devours other insects. It is the tiger of the insect world. It is one of the gardener's friends.

7. The lady-bird is another friend. In the larva stage it lives on the green-fly or blight, which often infest the plants in the garden.

## Lesson XX

## INSECTS WITH SCALE-WINGS

Articles required for illustration:—A collection of dead specimens, and Brown's picture of "Butterflies and Moths"; a sketch of the wing-scales as seen under the microscope; some eggs of the common white butterfly on a cabbage-leaf.

### I. One Family

1. *Show the specimens on the card, or failing that the picture, and lead the children, by a few carefully chosen questions, to tell all they can about them, as follows:—*

They are all insects. Each of them is **"cut into,"** and is made up of three distinct parts—the **head, chest,** and **body.** But they are altogether **different in appearance from the beetles.**

*If asked for the name of these insects, the children will probably say they are butterflies. Let this pass for the moment, and hand round the class a few dead specimens of the two kinds for the children to examine.*

2. *Lead them in their investigations to discover for themselves that:—*

(*a*) *Each of these insects has* **two pairs of large wings.**

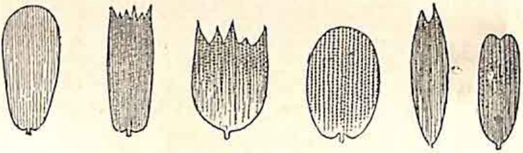
(*b*) *The front wings are not hard horny cases;* **both pairs are soft and delicate to the touch.**

*Call the attention of the children now to their fingers.* They are covered with **a fine powdery dust,** something like meal in appearance.

*Show that* **this dust comes off the wings.** *Rub all the dust off one of the wings, and point out that* **the wing itself is thin and delicate.**

3. *Show a drawing of this dust, as it appears under the microscope.*

Each tiny particle of dust is a **beautiful scale.** The wings are covered with these scales. Hence we put all these insects into one family, and call them **the scale-winged insects.**



## II. Two Branches

1. *Now let the children examine carefully a moth and a butterfly side by side, without distinguishing them by name for the present, and lead them to discover that:—*

(*a*) One has **a bigger heavier body** than the other.

(*b*) Both have **long feelers**; but **one has a knob at the end of each feeler,** the other has no knob.

(*c*) One has **more brilliant colours** than the other.

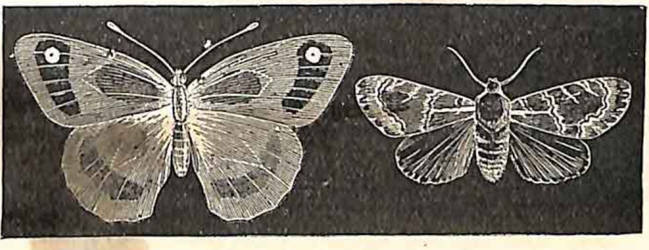
2. *Collect up these points of difference, as follows:—*

The one with **a big heavy body, feelers without knobs,** and **dull colours,** is **a moth.**

The other, which is marked in **bright beautiful**

**colours,** and **has knobs at the ends of the feelers,** is a **butterfly.**

Some moths, however, have slender bodies and bright



colours, and some fly by day. But they are always to be distinguished from butterflies by the absence of knobs on the feelers.

3. *In connection with the colours, point out that most of* **the moths are night insects,** while **the butterflies fly by day.** The brilliantly marked butterflies find a protection against their enemies in the **equally brilliant flowers** which they visit. They cannot easily be seen by the side of the flowers in the daytime.

In the same way the **duller colours of the moths** serve to protect these insects, for they **cannot easily be seen at night.**

MODE OF FEEDING.—*This will naturally lead to a further comparison between butterflies and moths, and the beetles of the last lesson.*

*Lead the children to discover, with the help of the specimens and the picture, that* **none of the family have large prominent jaws** *for biting and chewing, like those which we found in the beetles.*

*Tell that* **butterflies and moths live entirely on liquid food,** *mostly the juices of the flowers, which they take by suction. They have* **no need of jaws for biting and chewing** *solid food.*

## III. Life-History

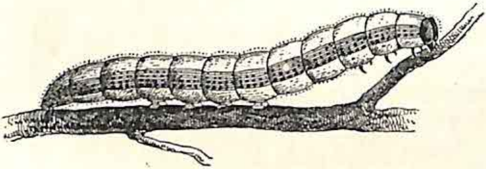
1. *Notice that, although the perfect insect lives by sipping the juices of the flowers,* **the larva or grub,** *which comes from the egg, is in every case* **a vegetable feeder.**

The mother insect lays her eggs, a few here and a few there, **where the young ones,** as soon as they are hatched, **can find plenty of food** exactly suited to their needs. Very soon after this she dies, but her young ones are well provided for.

2. *Take as an example the* **cabbage butterfly.** *Show the cluster of eggs (usually ten or a dozen, sometimes more) on the under side of a cabbage-leaf. In the absence of the actual thing, a picture must take its place.*

1. The Larva Stage.—What kind of creature is the larva or grub, which comes from one of these eggs?

*Show the caterpillar of this butterfly.*



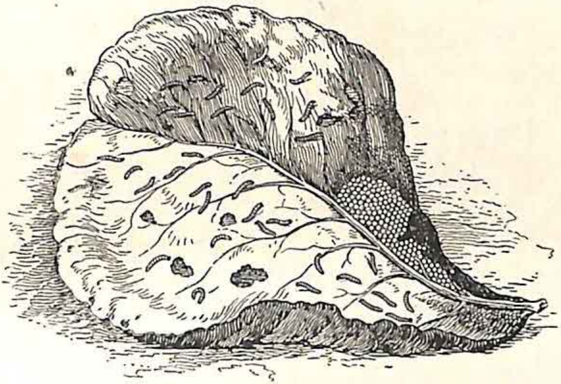
The larva or grub of **every kind of moth or butterfly is a caterpillar,** more or less like this one.

Caterpillars have **strong horny sideway-moving jaws,** for chewing the food on which they live. This one feeds on the leaves of the cabbage. It has a voracious appetite, **for day by day** it eats many times its own weight of food, and **grows as rapidly as it feeds.** *Show a well-eaten cabbage-leaf.*

2. *Point out that it is easy to see why the mother insect lays only a few eggs here and there. She has hundreds to lay, but*

**if she deposited them all in one place,** *the young ones would not find enough to eat.*

*It is equally easy to see* **why she is provided with**



**such beautiful wings** *for flight.* **She has to fly about in many directions,** *before she can deposit all her eggs. A crawling insect could not do this.*

3. *Refer next to the earlier lesson (Lesson XVII.), and lead the children to tell the result of all this feeding in the grub stage.*

After a time the grub gets so big that, **its skin is stretched almost to bursting.**

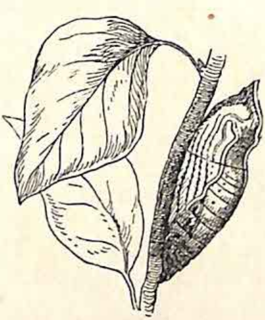
But by this time it seems to have lost its appetite, for **it leaves off eating altogether.** Then its skin begins to split, and little by little **the grub wriggles its way out of it, already provided with a new one.**

4. After eating up the old skin, which it has cast off, it sets to work again on the cabbage-leaves, feasting away as greedily as before.

It goes on in this way feeding and moulting for two or three months, and **it casts its skin four or five times during this period.**

*Remind the children that, in common with every kind of insect,* **all the growing is done in this larva or grub stage,** *and lead them to tell the rest.*

1. THE PUPA STAGE.—When it has reached its full size, it crawls away to some safe hiding-place, **hangs itself up with a silky thread of its own making,** and so remains, without moving or eating, for the next two or three weeks,[1] **wrapped up, like a baby in swaddling clothes,** inside a horny shell, which we call the **chrysalis.**[2]



2. When the final change is completed, it crawls out from its shell **as a perfect insect,** very weak, and with **damp crumpled wings.**

Little by little it spreads its wings open, for the air to dry them, and then it is ready to begin its new life, no longer an ugly crawling grub, feeding on vegetable food, but **a graceful creature flitting from flower to flower,** and fitted to live on the sweet juices which it sucks from them.

## SUMMARY OF THE LESSON

1. Butterflies and moths belong to the same family. They are known as scale-winged insects.

2. Butterflies have bright beautiful colours, and knobs at the ends of the feelers.

3. Moths, as a rule, have heavy-looking bodies, and the feelers are always without knobs.

4. The larva of every kind of moth or butterfly is called a caterpillar.

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[1] Those that commence the pupa stage in the autumn, remain in that state for the next six or seven months, and do not emerge from the shell till the next spring.

[2] The name chrysalis means golden. It is so called because the colour of the shell, or case, in several of the butterflies, especially those whose caterpillars feed on the nettle, is a golden brown.

5. Caterpillars have horny jaws for chewing the vegetable food on which they live. Moths and butterflies have no need of jaws for biting and chewing, for they live entirely on liquid food.

6. The pupa of these insects is often called a chrysalis; but this name is only properly applied to those, which are of a golden colour.

## Lesson XXI

## BUTTERFLIES AND MOTHS

Brown's picture of "Moths and Butterflies" will be required. As many actual specimens should be provided, as it is possible to obtain.

### I. Introduction

1. *Show the specimens and the picture.*

*The children will now have no difficulty in distinguishing the moths from the butterflies.*

*When that is done, point out that, not only do the moths differ from the butterflies, but each of the two kinds of insects has many varieties, which differ from one another in colour and form.*

2. Many of them, butterflies as well as moths, **make the trees their principal haunt,** each kind selecting its own particular tree.

Why should they go to the trees?

*Elicit from the children that animals, as a rule, frequent particular places, because the food which they require is to be found there.*

Do these moths and butterflies go to the trees for food?

3. *Elicit that both of them live by sucking the juices of the flowers, and then point out that the flowers of some of the trees, which they frequent, are entirely without honey.*[1] **Such flowers cannot supply these sucking insects with food.**

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[1] The flowers of the lime, and of many other trees, however, contain an abundance of very rich honey.

Then why should they go to the trees?

*Explain that the insects seem to be much more anxious about their young ones than about their own feeding*—**some of them never feed at all. They lay their eggs and die.**

4. Each one selects its own particular tree, and **there it deposits its eggs,** because instinct, in some wonderful way, tells the mother-insect **the kind of food the young grubs will like best.** The grubs when hatched feed upon the leaves of these trees.

Thus the oak is said to provide food for the grubs or caterpillars of more than 200 different kinds of butterflies and moths; the willow supports quite as many; the birch over 150; the poplar about 140; the elm about 60; the hazel about 50, and so on.

*It would be interesting now to point out in the picture, and describe briefly, a few varieties in both branches of the family, thus:—*

### II. BUTTERFLIES

**The Brimstone Butterfly.**—*Point out this one in the picture. It gets its name from its* **sulphur-coloured wings.**

*Tell that it is sometimes called* "**the harbinger of spring,**" *and explain that* it is one of the very first of the butterflies to make its appearance after the break-up of winter. The **buck-thorn** is its principal haunt.

The **common white,** or **cabbage butterfly,** the **orange-tipped,** and the **marbled butterflies,** all belong to the same class.

**The Peacock Butterfly.**—*Show this, either as a specimen or in the picture, and call attention to its beautifully marked wings.*

It is one of the **finest of our British butterflies,** and is very common in the fields and woods in most parts of the country. The caterpillar of this butterfly feeds on **the leaves of the common stinging nettle,** and is easily recognised, for its general colour is **black**, and it is **studded with tiny white spots.**

When it reaches the chrysalis or pupa stage, it hangs itself up by a thread to one of the leaves.

**The Scarlet Admiral**, a beautiful butterfly, which gets its name from the **broad scarlet stripes across its wings**, belongs to the same class, and is also to be met with in the neighbourhood of the **common stinging nettle.**

**The large Tortoise-shell Butterfly** and the **Comma Butterfly** are found on the **elm, hazel**, and several other trees.

But the most beautiful of all, and perhaps the scarcest of all, known as the **Camberwell Beauty**, lays its eggs in the **birch, poplar**, and **willow.**

*By pointing out in this way the peculiar haunts of each kind, the teacher might easily induce the children to search for the caterpillars during the spring and summer months.*

*Some of them might be collected, and kept in a perforated cage or box, which a little ingenuity would soon extemporise, and then the only trouble would be to provide a constant supply of the special food for each.*

*It would be worth all the trouble, for the children to watch the development from caterpillar to perfect insect, and to get an opportunity of seeing each one at last emerge from its chrysalis, in all the beauty of the perfect form.*

*The butterflies and moths might afterwards be preserved*[1] *for future reference.*

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[1] Following the advice which was given in the Preface, the teacher should make it his special aim **to guard the children against wanton destruction and needless cruelty** in this work of collection. He should carefully impress upon them that, in taking the life of even an insect, **we have no right to torture it.** It should be killed instantly and outright.

The Rev. J. G. Wood recommends the following as the most humane mode of killing insects for preservation:—Dip a fine-pointed

N.B.—*They are best kept in a closed box, with a little camphor or solid naphthaline to preserve them. They must not be exposed to the light or they will fade.*

## III. MOTHS

Among these the family of the **Hawk Moths** are all noted for their **swift flight.**

The most important of them all is the **Lime Hawk Moth,** so called because the **lime-trees** are its favourite haunt.

The larva of this moth is a **large green caterpillar,** with a sort of **pimply skin, red and white streaks** on the **sides of the body,** and a **big knob** near the tail end.

This caterpillar, when it has reached its full size, either buries itself in the ground, or hides away in a chink in the bark of a tree, and remains there in the pupa form all the winter.

1. **The Death's Head Moth** is the largest of our English moths. It sometimes measures nearly **6 inches across the wings,** and **the grub,** from which it comes, is **an enormous yellow and green caterpillar** quite 5 inches long.

*Point out the insect and caterpillar in the picture.*

2. The moth is strikingly marked. The head and chest

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steel pen, or some similar sharp-pointed instrument, into a strong solution of oxalic acid, and with it give the butterfly, moth, or whatever insect it may be, a sharp stab on the under side of the thorax, just between the first and second pairs of legs. The stab will sever the chief mass of nerves (which are situated in that spot), and the poison will carry instant death to the insect.

The head of an insect is not a vital spot. Hence the ignorant mode of trying to kill them by running a pin through the head is cruel and ineffectual. The little creatures have been seen to move about for twenty-four hours after being so pinned down.

Beetles may be killed instantly by plunging them into boiling water.

are **dark brown, almost black**; the body is **yellow, crossed with dark bands.** The front wings, like the chest, are **dark brown** with **wavy stripes and splashes of black and white**; and the hind wings are **ochre yellow,** crossed with **two dark wavy bands.**

3. *Point this all out in the picture, and then call attention to the peculiar* **skull-and-cross-bones marking** *just behind the head, which gives the moth its name.*

**The caterpillar** of this moth **feeds on the leaves of the potato,** and may often be found in the potato fields during the late summer.

THE GOAT MOTH.—*Point this out in the picture.*

It is almost as large as the Death's Head. **Its caterpillar is an immense grub,** and it sends out **a foul odour resembling that of the he-goat.** Hence the name.

It is one of the few caterpillars that make cocoons, and **the swallow-tailed moth** is another. This moth is named from the peculiar spur or tail at the end of the hind wing.

They both frequent the willow, lime, and elder trees.

1. THE CODLIN MOTH.—*Show, in the picture, the moth itself and its caterpillar or grub.*

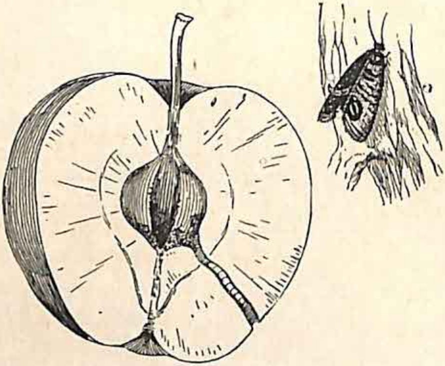
It is one of **the worst pests of the orchard,** and is sometimes called **the apple moth.**

*Remind the children that when they pick up a windfall in the summer and early autumn, they* **invariably find a maggot inside it.** *Tell its history.*

About **June or July** the mother-insect **lays her eggs, one at a time, on apples and pears.** The maggot or caterpillar, which comes from the egg, **eats its way to the core,** and there **feasts greedily upon the pips.**

2. *Remind the children that apples and pears, like all other*

*fruits, are merely the receptacle for the seeds—that* **it is Nature's aim to produce ripe seeds**—*and that the seeds, if left to themselves, would ripen with the fruit.*



CODLIN MOTH AND GRUB.

When once the seeds in the core have been eaten by this maggot, **the fruit is of no more use to the tree,** and hence it prematurely falls to the ground. **It is the maggot that causes the apple to fall.**

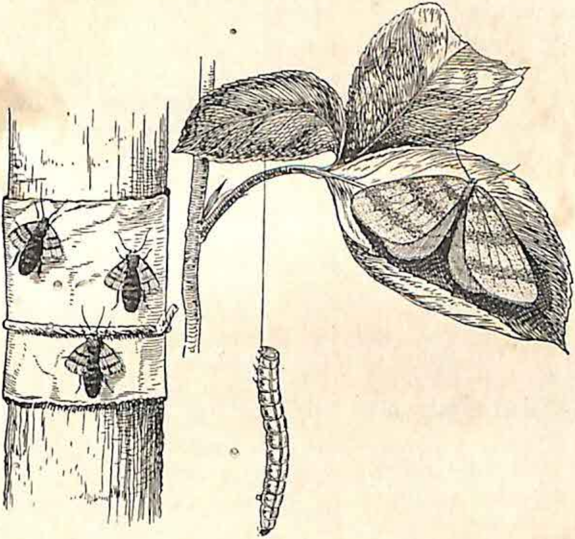
3. *Explain that the grub falls with it, and continues its feeding till it has eaten its fill, and has finished growing. It then* **crawls out of the fruit,** *and* **makes its way up the trunk** *of the tree, till it finds some* **snug crevice in the bark,** *where it can take up its abode for the winter.*

*In this hiding-place it envelops itself* **in a white web of its own spinning,** *changes into the* **pupa stage,** *and remains there* **till the following May,** *when it comes out in the form of a moth, to begin a new life, and* **lay the eggs of future generations.**

The best preventive against these destructive pests is **to destroy all windfalls,** before the grub can crawl out from the fruit, and then **lime-wash the trunks of the trees** in the early winter.

1. THE WINTER MOTH.—*This moth commits as great havoc among all kinds of fruit and forest trees, as the codlin moth does among apples and pears. It is specially destructive to stone-fruit. Point it out in the picture, and tell its history briefly :—*

It is known as **the winter moth,** because it does not make its appearance till **October or November.** The eggs are laid about this time, usually **in or near the young buds.** The caterpillars, which are hatched from them the next spring, often devour everything before them—buds, leaves, flowers, fruit, and all.



WINTER MOTH AND GRUB.

2. The grub finishes its work of destruction, and **is full-grown by May.** It then **spins a silken thread,** with which **it lowers itself to the ground,** where it buries itself in the soil, and there **remains in the pupa form** till the following October, when it emerges as a perfect

insect, to complete its life-work by bringing into the world an enormous family of equally destructive children.

3. The wings of the female moth are **very small,** and **not adapted for flight**; and it is the knowledge of that fact, which enables the gardener to protect his trees from the pest. As autumn advances, and before the moth appears, he binds the trunk of the tree with a **bandage of brown paper,** which is then covered thick with some **sticky substance,** such as **cart grease.** The female moth, unable to fly, has no other way of reaching the young buds, **except by creeping up the trunk.** In doing this she is **caught on the sticky bandage as in a trap.**

### SUMMARY OF THE LESSON

1. Many butterflies and moths frequent the trees. They go to the trees to lay their eggs. The leaves of the trees provide food for the grubs.

2. The brimstone butterfly is sometimes called the harbinger of spring.

3. The peacock butterfly is one of the finest of our British butterflies.

4. The death's-head moth is the largest moth found in this country. Its caterpillar feeds on the leaves of the potato.

5. The goat moth is nearly as large as the death's head. It gets its name from the foul smell it sends out, which has something of the odour of a he-goat.

6. The codlin moth and the winter moth are two of the worst pests of the orchard. The former feeds upon the young apples and pears, the latter destroys all sorts of trees.

# Lesson XXII

## INSECTS WITH TRANSPARENT WINGS

The teacher should be provided with Brown's picture of "Insects with Transparent Wings."

### I. Introduction

1. *Produce the picture, and at once proceed to call attention to the wings of these insects, comparing them, of course, with the* **shield-wings** *of the beetles, and the* **scale-wings** *of the moths and butterflies.*

*Hand one or two dead specimens round the class, for the children to examine closely, and lead them to describe the wings in their own way.*

They are **very thin, delicate,** and **transparent.** Let us call them **transparent wings.**

2. *Hold them up to the light, and observe how these delicate wings sparkle, and* **reflect the most beautiful colours,** *as the light falls upon them.*

*Point out the various insects in the picture now, and call upon the children to name them as far as they can, assisting, of course, where necessary.*

The **dragon-fly, may-fly, bee, wasp, ant, common fly, blue-bottle, gnat,** and **daddy-long-legs,** all have these delicate transparent wings. As far as the texture of their wings is concerned, then, all these insects seem to have a strong resemblance one to the other. Let us see what else we can learn about them now.

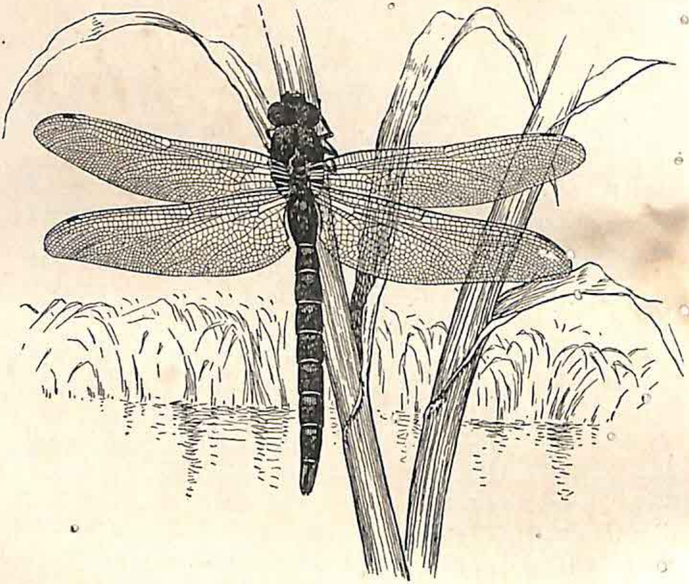
### II. The Dragon-Fly

1. *Turn once more to this* **large elegant insect.** *The children are no doubt quite familiar with it, but they most likely know it by the strange name of* **horse-stinger,** *although why*

*such a name has been given to it is difficult to understand, as* **it has no sting,** *and* **never attacks horses.**

*Notice the* **long slender body,** *and the* **two pairs of long gauzy wings.** *Call special attention to the delicate* **lace-like markings** *on the wings.*

2. These transparent wings are **full of veins,** which spread about in every direction. It is this **network of veins** which gives the wings their beautiful markings, **making them appear like lace.** Hence they are known as **lace-wings.**



DRAGON-FLY.

*Elicit that those long wings seem to have been made for* **rapid flight,** *and then explain that the dragon-fly is* **one of the swiftest** *of insects.*

It darts through the air **with lightning speed,** and can fly not only forwards, **but backwards as well.**

3. *Pass on next to show that, although the name* **horse-stinger** *is not a good one for this insect, it is very appropriately named* **the dragon-fly.**

*Ask the children to observe it* **in its favourite haunt by the river-side.**

It spends its time **darting hither and thither** with a **whiz** and a **whirr.** It is out of sight before we can turn our head. What is it doing all this time?

4. *Explain that it is* **chasing its prey** *through the air, for it is* **predatory in its habits,** *and* **feeds upon flies of all kinds,** *and even on* **butterflies.** *Remind the children of the myriads of insects, which are to be seen hovering over the water on a summer evening.*

It is a veritable **dragon of the air,** but far **more active,** and far more terrible to its victims, than even the **fabled dragons of old.**

5. It attacks its prey with its **lower lip,** which is armed at its extremity with **a pair of sharp forceps** for seizing the victim.

This weapon of attack is **neatly folded up** when not in use, but it is **very long,** and can be **thrust forward with the swiftness of thought.**

The **may-fly** belongs to this same class of **lace-winged insects.** It is a curious insect, for it comes into the perfect form **without a mouth, it never eats,** and **it lives only a single day.**

## III. BEES, WASPS, AND ANTS

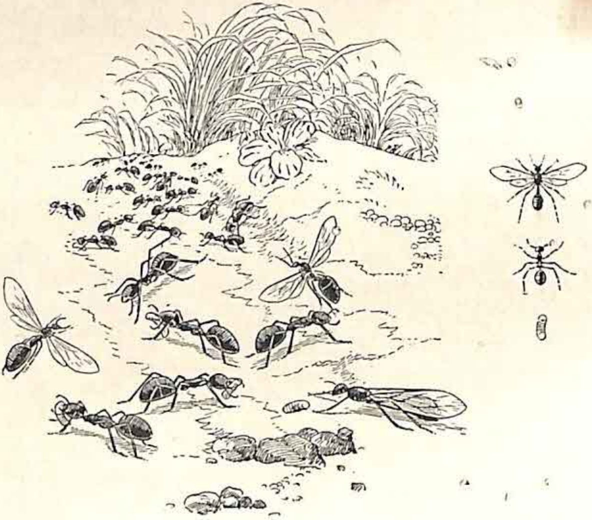
1. BEES AND WASPS.—*Proceed next to examine the* **bees** *and* **wasps,** *noticing as before the wings in particular. The children will observe that these insects, like the dragon-fly, have* **two pairs of transparent wings.** *But they will fail to find the same beautiful lace-like markings in them.* These, although transparent and gauzy, **are not lace-wings.**

*Point out the distinguishing peculiarity of these wings.*

*They are intended for* **rapid and prolonged flight.** *Remind the children that bees travel miles in search of the honey which they gather, for each flower supplies only the tiniest drop.*

2. On the front edge of each of the hinder wings are **a number of very small hooks.** During flight these hooks catch in **a fold of the front wing,** and so convert the two wings on either side into **a single wing.** It is this which gives these insects **their power of sustained flight.** Without it they would be unable to cover the long distances, and so it would be impossible for them to obtain sufficient food.

1. ANTS.—*Notice that* **some of the ants** *in the picture have* **two pairs of the same transparent wings**; *but* **others** *are* **wingless.**



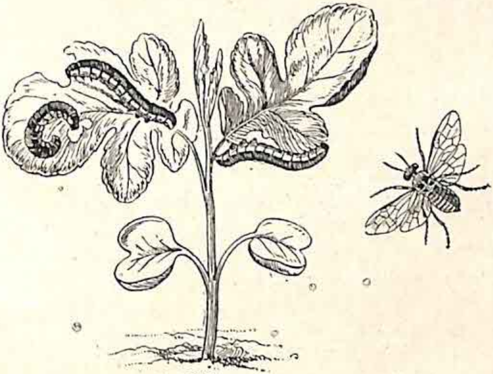
*The teacher will use his own discretion in explaining this. The facts are these:—*

*When they first emerge from the pupal form, the* **male and female ants are both winged,** *and as soon as they are strong enough for flight, they rise in the air to seek their mates. There is, however, another class of these insects, which are* **undeveloped females.** *They are known as* **neuters** *or* **workers,** *and resemble in this respect* **the worker bees.** *The* **neuters** *are* **wingless.**

2. *The male ant dies as soon as the mating-time is over, and the female then descends to the ground, where, after purposely* **snapping off her wings,** *she settles down to the business of* **laying her eggs.** *These are carefully* **carried away by the workers,** *who* **feed the young grubs** *which come from them, just as the worker bees do.*

*Explain that those little rounded objects, which are commonly known as* **"ants' eggs,"** *are* **not really eggs,** *but the* **pupal forms,** *in which the young ones are passing through the third stage of their existence.*

1. THE TURNIP-FLY.—The numerous family of insects known as the saw-flies have these same transparent gauzy wings. They are called saw-flies, because they are furnished with a **saw-like implement** at the extremity of the body, for the purpose of **making incisions in**



**certain plants,** in which they **deposit their eggs.** One of the most destructive of these is the **turnip-fly.**

*Point out this insect in the picture, and tell that this* **much-dreaded pest** *is often called* **the farmer's scourge,** *because of the ravages it commits among his root crops.*

2. It attacks the tender young plant, just when **the seed-leaves have pushed their way through the soil,** and strange to say, it has no further power for mischief, when once the plant is in rough leaf.

The farmer's chief anxiety, therefore, is to see his turnip and other root crops through to this stage, for after that they are **safe from attack.**

3. He sometimes **sows mustard-seed among the turnips,** as a means of prevention. The mustard begins to **sprout and grow more rapidly** than the turnip, and as the insect is equally partial to this plant, the eggs are laid on it before the turnips appear above ground. **The grubs feed on the young mustard leaves,** and so the turnip crop itself is saved.

He sometimes **drills in, with the seed, a specially prepared manure**[1] to induce rapid and vigorous growth, so that the young plants may **quickly get into rough leaf.** When the rough leaves appear, the plants are safe from the attack of this terrible fly.

4. Sometimes, in spite of all precautions, the crop is attacked. There is then no other remedy, but to **uproot and burn all the infested plants,** as soon as they appear with their leaves eaten.

## IV. Two-Winged Insects

1. *Call attention, in the next place, to the* **common house-fly,** *the* **blue-bottle,** *the* **gnat,** *and the* **daddy-long-legs.**

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[1] A mixture of superphosphate and gypsum is used for this purpose.

*Notice that these, like all the others in the picture, have* **transparent wings,** *and then lead the children to discover that, instead of two pairs of wings,* **these insects have only a single pair.**

We call them the **two-winged insects,** and the class includes not only these, but hosts of flies of many different kinds.

*The children will probably remember that, the* **gnat** *and the* **daddy-long-legs** *have* **a pair of balancers,** *to take the place of the hinder wings. Let them point these out now.*

*The life-history of these insects should be noticed in conclusion :—*

2. Flies and blue-bottles lay their eggs in the **dead bodies of animals,** and also in the **meat, cheese,** and **other provisions** in the larder, which of course serve as a food-store for the **larvæ** or **gentles,** which are hatched from them. The gentles **feed ravenously for about ten days,** and then, having reached their full size, prepare for the change into the **pupa** or **chrysalis.**

*Show some of the gentles, and also one or two of the* **brown horny cases,** *in which the grubs are passing the* **pupal stage of their existence.**

3. The **eggs of the daddy-long-legs** are laid[1] in the soil of the meadows and pastures, and the grubs, when hatched, become a fearful pest, for they **feed on the roots of the grass,** and do considerable damage.

### SUMMARY OF THE LESSON

1. The dragon-fly, may-fly, bee, wasp, and ant; the turnip-fly and other saw-flies; the common house-fly, blue-bottle, gnat, and daddy-long-legs, all have thin transparent wings.

2. The beautifully-marked wings of the dragon-fly are known as lace-wings.

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[1] The life-history of the dragon-fly and the gnat will be dealt with in the next lesson.

3. Bees and ants are male, female, and neuter. The neuter ants have no wings.

4. The turnip-fly attacks the root crop, just as the young plants are sending up their seed-leaves.

5. The common house-fly, blue-bottle, gnat, and daddy-long-legs belong to the family of two-winged insects.

6. The eggs of the daddy-long-legs are laid in the soil of the meadow. The grubs feed on the roots of the grass.

## Lesson XXIII

## SOME CURIOUS INSECTS

Provide for illustration Brown's picture of the burying-beetles, and other insects dealt with in the lesson.

But an effort should certainly be made to procure actual living specimens of the water-beetles, the caddis, and as many others as possible, so that the children may observe for themselves the habits of these creatures.

At the time of writing, **the author has in his London school**, a living collection of **various water-beetles** (including the **water-boatman**), the **caddis, water-snails, minnows, tadpoles, newts**, etc.; and needless to say they are a source of great interest.

It is necessary of course to provide separate aquaria for some of these. The tadpoles, for instance, would fare badly if placed in the same water with the newts and minnows. But a few large glass bowls or jars would serve every purpose, and they can stand permanently on the table in front of the class.

The result fully repays one for the trouble of making the collection, even in a place like London; and in the country of course that trouble would be scarcely felt, for the children themselves would be glad to bring the specimens.

### I. THE BURYING-BEETLE

1. *SHEW the picture, and explain what these beetles are doing.* They have found this **dead bird lying on the ground,**

and they are **hard at work burying it.** What can be their object in this?

*From what the children already know of the habits of various insects, they will be easily led to infer that,* the body of the bird **is intended to provide a store of food for the young grubs** of these beetles, when they are hatched from the eggs.

*Tell that these insects always select the dead body of some animal*—**a mouse, a mole,** *or* **a bird**—*for this purpose, because* **the grubs feed on putrid flesh.** Because of this habit they are called **Burying-Beetles.**

2. *Note that the dead carcase is much* **too heavy for the insects to move,** *and then describe their method of burying it.*

They **scratch away the earth under the body,** till they have made a hole so large, that **it sinks in** of its own weight. Then they **burrow underneath this,** to still further enlarge the hollow, so that at last the body is deep enough to be **completely covered** with the soil, **which they scrape over it.** The burying work is quite finished in a few hours.

3. That done, the female beetles, with the help of their **egg-depositors, lay their eggs in the buried body,** and its putrefying flesh affords nourishment for the young ones in due course.

*Show that, in carrying out this work, these beetles render us a service.* **They act as scavengers,** for they bury **the rotting body** of the animal, whatever it may be, and **so prevent it from giving off bad smells,** to taint the air.

## II. THE DUNG-BEETLE

1. *Point this one out in the picture, and explain that, like the burying-beetle,* **it acts as a scavenger,** *and with the very same object—that of laying its eggs.*

It does not choose a dead body for this purpose however. **It lays its eggs in cow-dung,** and buries that—

the dung of course being intended as **a food-store for the young grubs.** Hence the name—**dung-beetle.**

2. *It is interesting to note the immense amount of care these beetles take in providing for their young.*

They bore a **hole in the ground**, work the dung up into **a round ball,** place **one egg in the middle of the ball,** and then **roll it into the hole** they have made, covering it up afterwards with earth, and this is repeated again and again with every egg they lay.

3. *Explain that this is the beetle referred to in Gray's elegy :—*

> "Save where the beetle wheels his droning flight."

It is well known to most country boys, who call it **the watchman,** because as evening comes on, it seems to resemble in its whirling flight a watchman going his regular rounds. It is also known as the **dorr-beetle,** because of the **humming droning sound it makes,** as it wheels its way through the air. **Dorr** is another word for **droning.**

## III. THE GLOW-WORM

1. *Point out this little insect in the picture, and show that it has been badly named.* It is **not a worm** at all, but **a beetle.**

*Many of the children have no doubt seen the pale blue light of the glow-worm on a summer evening, but few of them probably know anything of the little creature itself.*

2. Seen in the **daytime,** when of course it is **not luminous,** it is found to be **a small brown beetle.** The **female has no wings,** and crawls about **more like a grub** than a perfect insect; but **the male has large flight-wings** like other beetles. The peculiar **glow** or **light** which it shows is **in the end of the tail.** It was

once thought that the female alone possessed this light, but that is not correct, as **male and female are both luminous.** The female, however, has the more brilliant light.

3. *Tell that* **the grubs** *of these insects* **feed on young snails.** *Remind the children of* **the slime which snails send out** *from their bodies.*

*It is curious to observe that* the glow-worm grub is **provided with a sort of brush** at the end of its body, which it uses **to cleanse itself from this slime** after its meal, and draws back inside the body when not in use.

## IV. WATER-BEETLES

1. *Show living specimens of these in a bowl of water. There need be no difficulty in obtaining them, for* **they swarm in ponds, lakes,** *and* **rivers** *everywhere.*

*Call attention to their movements in the water, as they dive down to the bottom, and rise to the surface again.*

2. *Notice the* **peculiar form of their hind legs,** *which are* **flattened out into a sort of blade,** *with a* **fringe of stiff hairs** *on their edges.* These **serve as oars** to propel the creature through the water.

3. *Notice the little* **round glistening bubbles,** *which appear one after another,* **just under the wing-cases** *of these beetles, as they swim about in the water.*

*Observe that the beetles make their way up to the surface from time to time.*

*Remind the children that insects of all kinds* **breathe through spiracles, or breathing-holes in the side of the body.**

4. *Then explain that :—*

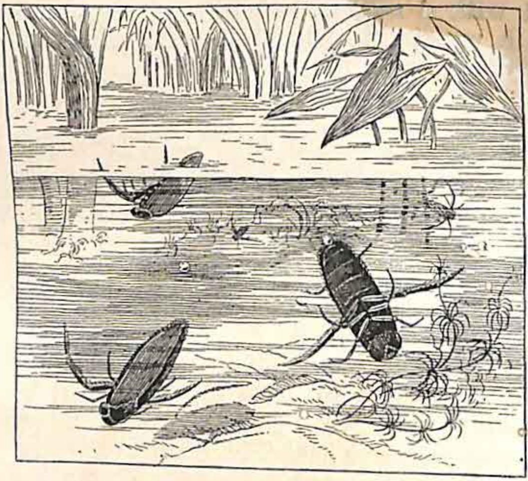
(*a*) These beetles **cannot breathe in the water;** they must come up to the surface to breathe.

(*b*) They take in **a supply of air through their spiracles,** to last them while they are under water.

(*c*) The spiracles are **shut in by the wing-cases.**

(*d*) The air they take in is gradually exhausted, and **sent out in little bubbles,** which burst one after another **near the tail.**

(*e*) When the air in their bodies is exhausted, they **make their way upwards for a fresh supply.**



5. The most curious of these water-beetles is known as the **water-boatman.**

Unlike many of the family, it **does not live entirely in the water,** for it flies well, and takes frequent excursions into the air. Still, it spends much of its time in the water, for **it finds its food there.**

*Show one of these beetles, if possible. It is very interesting to see the creature* **turn over on its back,** *which is shaped something* **like the keel of a boat,** *and actually* **row itself along with its two oar-like legs.**

## V. THE DRAGON-FLY, GNAT, AND CADDIS

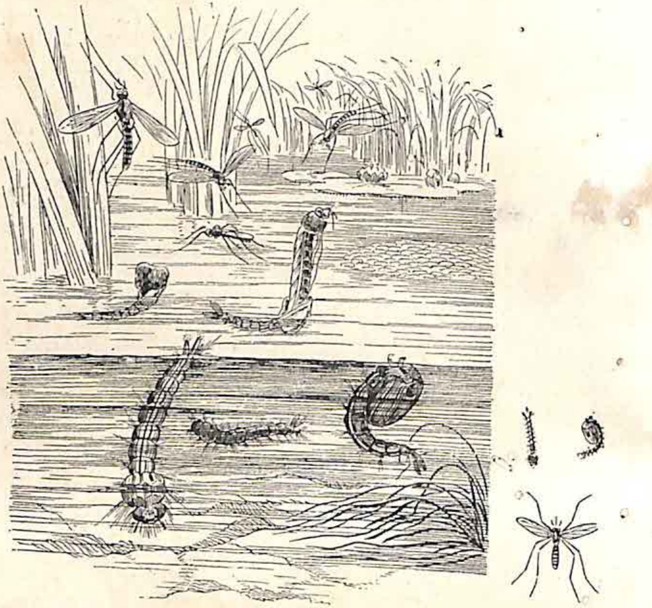
1. THE DRAGON-FLY.—*The life-history of some insects is full of interest, as* **they spend the three first stages of their existence under water,** *only leaving it after reaching the perfect form.*

First among these is the **dragon-fly.** The eggs are laid in the water, and, strange to say, the grubs which come from them **commence their predatory habits from the first,** lying in wait for insects and other creatures, and **devouring them greedily.** As they grow **they moult,** of course, **from time to time** like other grubs, and when the time for the last moult arrives, (which is usually about **the end of June,** or the **beginning of July**), they crawl upwards into the air, **clinging to the rushes and other water-plants.** On reaching the surface of the water, the skin dries and **splits down the middle of the back,** and then after a few struggles, they emerge from the pupa-case **with the lightest of gauzy wings.** The warm sun soon **dries the body and wings,** and then they raise themselves in the air, to begin their new life.

2. THE GNAT.—The **life-history of the gnat** is equally curious. The mother-insect lays her eggs during the spring in some **ditch** or **stagnant pool,** and here they may be seen **floating about on the surface of the water, glued together,** 200 or 300 in a mass.

The grubs are hatched in a few days, and **feed on the decaying vegetable matter** in the water. When they are full grown, and the time for the pupal change arrives, the pupa **hangs head downwards in the pool,** breathing all the time through two small slits, which open near the tail end, and above the surface of the water.

When, in about ten days the change is complete, **the horny case of the pupa splits** down the back, and the perfect insect, after extricating itself, unfolds and **dries its wings,** floating all this time on the surface of the water in its discarded clothing, which serves as a sort of raft. It leaves the raft as soon as the wings are quite dry, and it is then free to flit about in the air.



3. THE CADDIS, or STONE-FLY, is another insect which **begins life in the water.**

*Get one of these, if possible. It is most interesting to watch these grubs in the water.*

They collect together **bits of material**[1] of various sorts, and **build them up into a case** or **shell** all round themselves, and this forms **their permanent residence** during their life in the water. Wherever the grub goes, **it carries its house with it.**

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[1] Small flat stones, bits of bark, sand, grass, grass-stalks, and shells are among the various materials used by the caddis for its building purposes.

### SUMMARY OF THE LESSON

1. The burying-beetles get their name from their habit of burying the dead bodies of mice, moles, and birds. They lay their eggs in the dead animal, and the grubs feed on the putrefying flesh.

2. The dung-beetle in a similar manner lays its eggs in a ball of dung, and buries that in the ground.

3. The glow-worm is a small brown beetle. The glow, or light, which is seen after dark, is in its tail.

4. The water-beetles propel themselves through the water, using their hind legs as oars. They cannot breathe under water.

5. The most interesting of the family is known as the water-boatman.

6. The dragon-fly, gnat, and caddis, pass through the three first stages of their existence in the water. They leave the water as perfect insects.

## Lesson XXIV

## BEES AND BEE-KEEPING (1)

Provide the teacher with Brown's pictures of "Bees," a pot of honey, and a specimen of the comb; and one or two dead specimens of the humble bee, for close inspection by the class.

### I. INTRODUCTION

1. *COMMENCE by reminding the children that, by far the greater number of the insects we have already mentioned—beetles, butterflies, and moths—are our positive foes. Either* **the insects themselves,** *or* **their destructive grubs,** *or both,* **devour the crops in the fields, the plants in the garden, the leaves on the trees,** *and often* **the trees themselves.**

To-day we are going to talk about another class of insects—the bees—which are **useful all round.**

They are useful to the growing plants. Why?
They are useful to man. Why?

2. *Refer the children to their earlier lessons on the bee (Book I. Lessons XXIX. and XXX.), and lead them to tell all they can about the insect and its work.*

*Elicit that there are three kinds of bees in the hive—the* **queen,** *the* **workers,** *and the* **drones,** *and let the class describe each briefly.*

*Show the picture of "Swarming," and call upon the class to tell what it all means, and what becomes of the bees.*

3. *Sketch on the black-board the interior of the hive, and let the children tell what they can remember of the use of the* **movable frames.**

*Assist them to describe, in their own way,* **the nature of the comb,** *which the bees build on either side of the frame, and the purposes to which the cells are put.*

4. *After recapitulating so far, and before passing on to deal more fully with the hive bees, pause to say a few words about the other members of the family :—*

THE HUMBLE BEE.—*Show the live insect under a glass, or a dead specimen. The children are all familiar with it, and with the* **"humming," "buzzing" sound** *it makes as it flies.*

*Point out that* it is **much larger than the hive bee,** and that it is **covered with yellow and black hairs.**

*Tell that* it makes a sort of **nest of cells in the ground,** laying its eggs in some of them, and using the rest as a storehouse for a poor kind of honey, which it gathers.

5. WILD BEES store their honey **in hollow trees,** and in **holes in the rocks.**

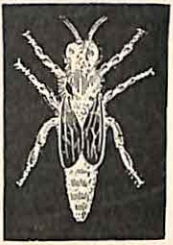
**Wasps and hornets** are vicious members of the same family, **much dreaded on account of their stings.** They are met with everywhere, and do considerable damage among the ripe fruit.

## II. THE HIVE BEES

*Proceed next to deal with the hive bees, eliciting as much as possible from the children, and enlarging upon what has been taught in the earlier lessons.*

The colony in the hive consists of **one queen, a few hundred drones,** and usually from **30,000** to **50,000 workers.**

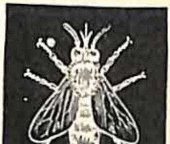
THE QUEEN.—*Let the children point her out in the picture, noticing the* **long slender body,** *and the* **very short wings.**



She cannot fly far. She remains in the hive, **the one business of her life** being **to lay eggs.**

She lays from **2000 to 3000 eggs a day** during her prime,[1] placing **each egg in a separate cell.**

THE WORKERS. — *With the help of the picture again compare these in size and appearance with the queen.* They are **much smaller,** but their **wings are large,** and well fitted for flight.



The queen is a perfect female bee; the workers are females too, **but they are not fully developed.**

The workers **do all the work** in the hive. They **gather honey and pollen,** and store them up; they **make wax,** and **build the cells**; they **act as nurses in feeding the grubs** that come from the eggs; and lastly as winter approaches they **set upon the drones,** and drive them away or sting them to death.

As a rule, the summer broods **do not live more than six**

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[1] *N.B.*—Queen bees are considered to be in their prime during the first and second years, and it is not advisable to keep them longer, although they would live four or five years if left to themselves.

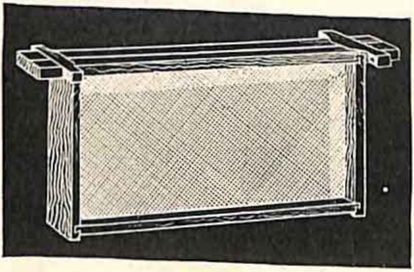
**or eight weeks**; they seem to work themselves to death. But those that are **hatched in the autumn** live through the winter, and are **ready to commence the year's work as soon as spring returns.**

THE DRONES.—These are the **male bees.** *Show the one in the picture, compare it with the other two, and call upon the class to tell all they can about it.*

## III. THE COMB

MOVABLE FRAMES.—*Show a sketch of one of the movable frames with its* **wire gauze partition,** *on either side of which the cells are to be built.*

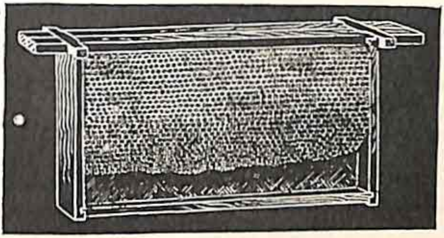
The British Bee-keepers' Association frames are all made of one size—**14 inches long** by **8½ inches deep,** and the **wooden framework** itself is **⅞ inch wide.**



*Show next the picture of the same frame, as it appears when it has been* **filled up with comb on both sides.**

The bees **make their combs ⅞ inch thick,** with the wire gauze partition to form the base of the cells on either side. That is to say, **the comb fills up the whole of the space in the frame.**

*Point out that the purpose of these frames is to enable the* *bee-keeper to* **lift out the comb, and examine** *it from time*



*to time, and to* **remove it entirely when it is filled with honey.**

1. COMBS EMPTIED AND REPLACED IN THE HIVE.—*Remind the children that the wax, with which the bees build their comb, is not gathered. It is prepared in their own bodies from the honey they have eaten.*

*Tell that* if all the combs in an ordinary-sized hive were emptied and weighed, there would be about **2 lbs. of wax**; and it has been estimated that, **to produce a single pound of wax, the bees consume from 12 to 20 lbs. of honey.**

2. *Point out that, if the bees are allowed to eat the honey themselves, it means a direct loss to the bee-keeper; and further that while they are preparing wax and building comb,* **they are losing time,** *which might be better employed in* **gathering and storing honey.**

*Tell that these considerations have shown the bee-keeper the wisdom of* **preserving the combs for future use.**

By using these movable frames, not only can **the combs be lifted out** when they are full of honey, but with the help of a machine called the **honey-extractor,** all the honey can be removed, **without any injury to the combs** themselves. They can then be at once **replaced in the hive** for the bees to fill again.

1. COMB FOUNDATION.—*Tell that, with the same object of*

*preventing waste and loss of time in the hive, the skilful bee-keeper has learned how to help the bees in another way.*

It was found that, when the bare movable frame was first placed in the hive, for the bees to fill with comb, **they would build in almost any direction but the one he wished.** Then some one thought of a plan of helping them, by fixing **a narrow strip of wax on the under side of the top bar** of the frame, as a sort of **foundation,** on which they might **begin to build.** When this was done, the bees took it as a hint, and starting from this foundation, **built their comb neatly and regularly** downwards, till the whole of the frame was filled up.

OLD-FASHIONED SKEP HIVES.

2. Comb-foundation is now used in all the **movable-frame hives,** but on a much improved plan. *Describe this.*

A **sheet of wax,** the size of the frame, is stamped out by machinery into **six-sided cells,** and this is **fixed securely** to **the wire partition** with melted wax.

When the frame is placed in the hive, the bees find the cells already made for them, and they have little else to do but **fill them with honey,** and **close them as they are filled.**

3. *Show a picture now of the* **old-fashioned skep hive,** *in which the bees were practically left to themselves, and point out the advantages of these improved methods, which have thus* **made bee-keeping a profitable occupation.**

### SUMMARY OF THE LESSON

1. The humble bee, wild bee, wasp, and hornet are all members of the same family.

2. In a hive there are one queen, a few hundred drones, and from 30,000 to 50,000 workers.

3. The queen lays from 2000 to 3000 eggs a day; she puts each egg in a separate cell.

4. Modern hives have movable frames for the bees to build on. When the combs are full of honey, they can be easily lifted out without disturbing the bees.

5. The honey can be extracted from the comb without injuring it. Then the frame, comb and all, can be replaced in the hive again.

6. A wax comb-foundation is usually fixed on the new frames. This contains the cells ready made. The bees have only to fill them with honey and close them up.

## Lesson XXV

## MORE ABOUT BEE-KEEPING (2)

Provide for illustration Brown's pictures of "Swarming and Hiving."

### I. BROOD CELLS

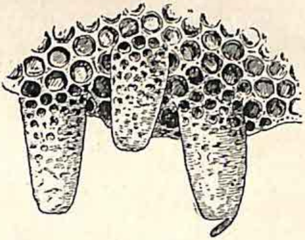
1. DISTINCT FROM HONEY-CELLS—*After running rapidly over the subject of the last lesson, commence by reminding the children that, some of the cells in the hive are used as nests*

**for the queen's eggs,** *and so lead up to the fact that,* **besides honey cells,** *there are others, which are known as* **brood cells.**

2. NOT ALL ALIKE.—These brood cells are not all alike in shape and size. There are **worker cells, drone cells,** and **queen cells.**

The **worker cells** are **the smallest** of the three. Five of them side by side measure an inch across; there are **twenty-eight of them to the square inch.**

The **drone cells,** being larger, **take up more room. Four of them measure an inch across,** and there are **eighteen to the square inch.**



The **queen cells** are **the largest** of all. They are **like an acorn** in shape, and have **very thick walls. They hang from the comb,** mouth downwards; they are about **an inch deep,** and **one-third of an inch across.**

3. SEALING THE CELLS.—*Show each of these, in the picture, and remind the children that the cells are built* **on both sides of the frame foundation.**

*Tell that the* honey cells are **sealed up with wax** when full, but the brood cells are **capped with a mixture of wax and pollen.**

*Explain that the mixture of wax and pollen is more porous than the wax alone would be. Elicit from the class the purpose of capping the brood cells with this mixture instead of wax.*

The bees seem to know that the tiny things inside those cells **must have air to breathe.** Air can pass into these through the porous cap.

The honey in the other cells **keeps best shut up close from the air.** Hence they **cap these cells with wax.**

Who taught them all this?

*Notice the cap at the bottom of the Queen Cell in the picture.* It is open, because the newly-hatched queen has passed out. The other cell by the side of it is still closed up; **a queen bee in the pupa form is inside.**

4. HATCHING AND NURSING.—The grubs are hatched from the eggs in 3 days, and henceforth till the 9th day they remain in the larva state, all this time being **constantly fed by the nurses,** for like all grubs **they are hungry feeders.**

After the 9th day **the cell is sealed up by the nurses,** and the grub, which has now reached its full size, **changes into the pupa form.**

5. The perfect queen bee emerges from the bottom of her sealed cell on the 16th day; but the worker bee does not leave its cell till the 21st day, and the drone is 24 days from the time when the egg was laid, before it reaches its perfect state.

## II. WINTERING THE BEES

1. *Picture the hive and its inhabitants in the winter. The queen still lives, but the community over which she reigns is smaller than it was in the summer, for* **all the summer worker bees are dead**—*immense numbers die before autumn.*

*Only those which were* **hatched in the autumn are now alive** *in the hive.*

2. *Tell that before winter comes on, the bee-keeper removes some of the frames, leaving as a rule* **six only instead of ten.** *He then makes a sort of inner wall all round them with* **close-fitting division boards,** *fills up the space* **between this and the outer wall with chaff,** *and covers the top of the frames with a quilt,*[1] *which is also* **spread thickly with chaff.**

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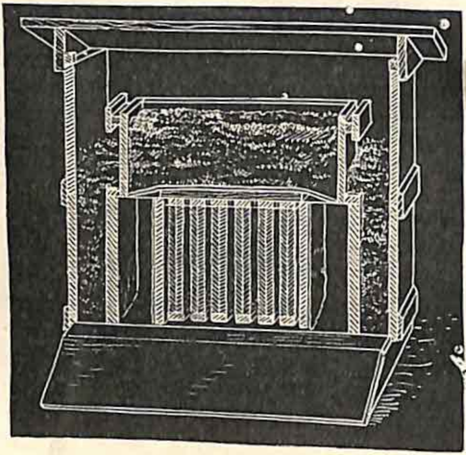
[1] The winter quilt consists of a sheet of "ticking" or unbleached calico, with a square or two of light drugget or flannel over it.

*Sketch on the black-board a section of the hive prepared for winter.*

3. This of course is a protection against the cold, and the bees, **kept warm all through the winter,** are ready on the return of spring to commence operations. The queen begins to be busy once more **laying her eggs,** and the nurses and other workers **soon find plenty to do.**



SECTION OF HIVE SHOWING ARRANGEMENT FOR WINTERING THE BEES.

## III. Swarming

1. *Point out that, among the thousands of eggs laid from day to day, there are almost sure to be one or more queen's eggs.*

*Remind the children of* **the peculiar form of the queen cells,** *and explain that the bee-keeper, in rearranging the hive, and replacing the rest of the frames,* **can tell them at a glance.** *Then he knows what to expect.*

The young queen emerges from her cell in due time, so that now there are **two queens in the same community,** and of course disturbances soon begin to arise,

**the rival queens generally fighting fiercely** with their stings at last.

2. But it always ends in **the old queen rushing out of the hive,** followed by **an immense seething crowd** of almost frantic bees, which **look like a liquid stream,** as they **pour out through the doorway.**

*The children will tell the rest.* **The queen cannot fly far**; *she alights on the first resting-place she can find—generally* **the branch of a tree**—*and the whole swarm* **crowd on after her,** *till they* **look like an immense bunch of grapes,** *as they hang from the bough.*

3. There is no stated time for this first swarming, as it all depends upon the weather.

But in a mild early spring it generally takes place **about the end of May** or the **beginning of June,** and occasionally as early as the **end of April,** or the **beginning of May.**

*Point out that, after this first swarming is over, there are still* **thousands of eggs hatching** *inside the hive—* **thousands of perfect young bees emerging from their cells** *day by day, and amongst them* **perhaps other queens.**

4. Should a new queen make her appearance, the one in possession **rushes at her with a shrill piping scream,** and **tries to destroy her.** This is prevented by the other bees, which crowd around them, and keep the two apart, and in the end, **the queen,** failing to kill her rival, **rushes out of the hive, followed by a crowd of bees as before.**

In this way **a second swarming** takes place; and this is termed **an "after-swarm"** or **a "cast."**

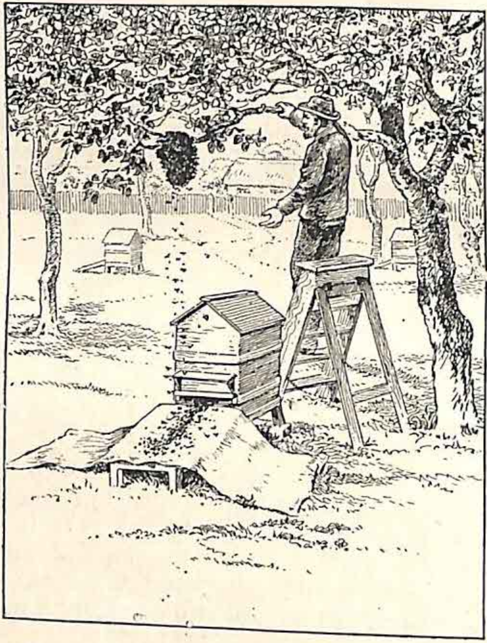
5. The first swarm is considered the best; the second may turn out profitable if it is an early one; but later swarms are of little value.

A swarm of bees in May is worth a load of hay;
A swarm of bees in June is worth a silver spoon;
But a swarm of bees in July is hardly ever worth a fly.

## IV. Hiving the Swarm

1. *Several methods of hiving are practised. One was described in Book I. Lesson XXX.*

*Lead the children to tell what they can of it now:—*



The hive, with a pot of syrup inside, is brought to the spot, and **placed just below the clustering swarm,** with a sheet spread on the alighting-board and the ground in front of it. **The bee-keeper gently shakes the bees** from the bough; they **drop on the sheet,** and make at once for the sweet syrup inside the hive.

2. *Describe the other methods now*:—

In one of these plans, the hive is not brought to the spot, but **the bees are shaken from the bough into a straw skep,** and the skep is inverted on a board and **carried to the hive,** which has previously been prepared to receive the swarm.

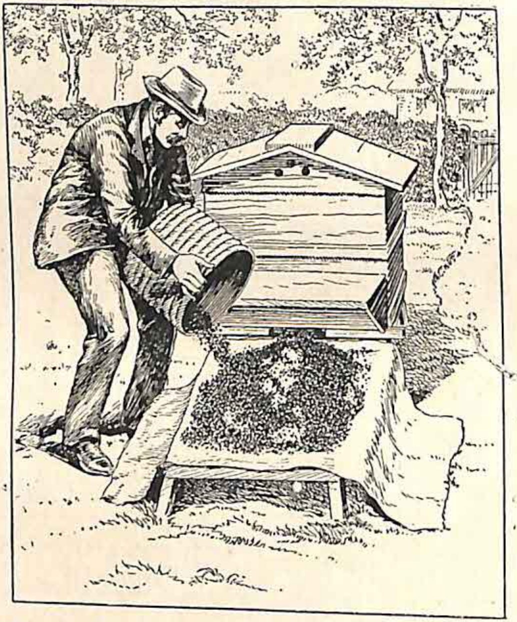
After waiting till all is fairly quiet inside the skep, **the bee-keeper pours the bees out on the white sheet,** and the smell of the syrup is generally sufficient to **entice the whole swarm inside the hive,** which they enter, crowding in with a joyful hum.

3. Some bee-keepers adopt the plan of **cutting off the branch itself,** on which the bees are swarming. This

requires to be done with very great care, so as **to avoid any jarring**, or the bees may get irritated.

When the branch has been successfully severed, it is **carried carefully** to the spot, where **the hive** (prepared as before) **is waiting to receive its new tenants.**

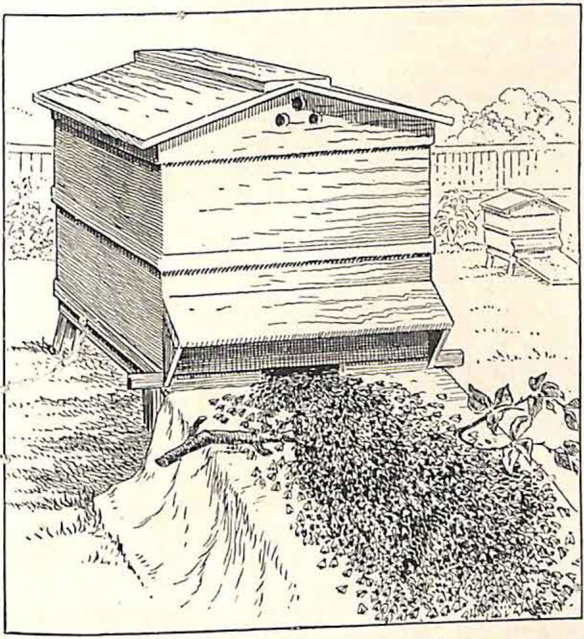
The branch is simply laid on the sheet, and **the bees hive themselves,** attracted by the smell of the syrup inside.



4. *Remind the class that sometimes the bees lose their queen—she does not enter the hive with them—and let the children tell the rest.*

The bees **will not remain in the hive without her.** They rush out in a **wild frantic state,** and if they find her, **they will swarm again,** but if they fail to find her, **they fly away and get scattered and lost.**

5. *Refer to the spiteful temper of the bees at this time, and lead the children to tell of the precautions, which the bee-keeper takes to protect himself against their stings. He has* **to use the greatest despatch in hiving them** *too, for they get more and more difficult to manage,* **the longer they are out of the hive.**



*Tell that some bee-keepers are* **so skilful in managing the bees,** *that they go about the work fearlessly,* **without either gloves or veil.** *The bees rarely if ever attack them, because* **everything is done so smoothly and so quickly,** *that they have not time to lose their temper.*

## SUMMARY OF THE LESSON

1. The cells in which the queen bee lays her eggs are known as brood cells.

2. There are queen cells, worker cells, and drone cells.

3. The queen cells are easily distinguished from the drone and worker cells.

4. The nurses feed the young grubs from the time they are hatched.

5. The bee-keeper prepares the hive to keep the bees warm through the winter.

6. Bees rush out of the hive, and swarm, owing to the jealousy of rival queens. Two queens cannot live together in the same community.

7. The first swarming usually takes place in May.

8. Later swarms are known as "casts" or "after swarms."

9. There are several methods of hiving the bees.

## Lesson XXVI

## MANAGEMENT OF THE HIVE

The teacher will require a picture showing Bingham's Smoker in use; an actual smoker where it can be obtained, a picture of the hive in several storeys.

### I. BEES AND THEIR STINGS

1. *COMMENCE by recapitulating the closing section of the last lesson, in order to remind the children of* **the bee's sting,** *and the spiteful use it makes of it when it is irritated. Remind them too that it is only the female bees*—**workers and queens**—*which are furnished with these stings.* **The drones have no stings.**

*Point out that it is this power for spiteful mischief in the bees, which makes bee-keeping a somewhat hazardous undertaking.* It is a very serious matter to be attacked by them, for when they get spiteful, the whole swarm will rush upon the unlucky individual from every side, and sting wherever they can find a bare spot.

2. *Tell, however, that although bees are so dangerous, they are*

**easily manageable,** *and can be* **kept under complete control,** *if they are* **intelligently handled.**

The first essentials in dealing with them are **gentleness, quietness,** and **absolute fearlessness** on the part of the manipulator.

*Point out that* **fearlessness in danger of any kind** *must be the outcome of* **thorough self-reliance,** *and that self-reliance belongs only to the person,* **who knows exactly what to do in the emergency.** In this sense **knowledge is power.**

*Point out further that the bee-keeper, like all other students of Nature,* **obtains his knowledge by careful observation.**

3. It has been observed by watching the bees closely that, **when they are alarmed** in any way, they rush at once to their combs, and **gorge themselves with honey** from their store. It has also been noticed that, **with their honey-bags full,** they invariably become **quieted down,** and **lose their spitefulness,** never attempting to sting unless they are hurt.

This **knowledge,** gained from observation, **becomes a power** to the manipulator.

Let us see what use he makes of it.

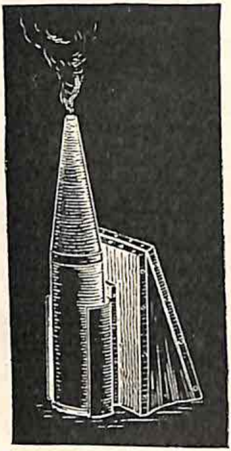
## II. The Use of the Smoker

1. *Produce and describe the* **smoker,** *or a picture of the contrivance, where the real thing cannot be obtained. Show how it is used, by putting into it some* **smouldering brown-paper, rags,** *or* **dry rotten wood,** *and puffing out the smoke in large or small volumes, as desired. The manipulator always uses some substance of this kind, which will burn and smoulder slowly.*

2. *Explain that* when he wishes to **examine the combs,** or **manipulate the hives** in any way, he slightly **raises the quilt,** and **blows a few puffs** of this smoke under it.

*The children will readily infer the rest.* The smoke **is annoying to the bees**; they rush to their store and begin to solace themselves with honey; and **when once they are full** he is master of the situation, and by using care **can do what he pleases with them.**

*Tell that some bee-keepers use* **gloves** *and* **a veil** *for the work, but others are so sure of their ground, and so skilful in managing the bees, that they go about the business* **quite fearlessly, without protection of any sort.**



THE SMOKER.

### III. NATURAL SWARMING

1. *Refer once more to the swarming and hiving of the bees, as described in the preceding lesson, and lead the children to tell all they can about it.*

This is known as **natural swarming**; the bees act **of their own accord,** and without any outside interference.

Natural swarming usually takes place **about the time, when the apple-trees are in full bloom.** At this time the colony is **very crowded,** there is **unusual activity among the bees,** and **many drones may be seen** hovering about near the hives.

2. *Explain that it is necessary for the bee-keeper to know, with some amount of certainty, what he has to expect, and therefore with the help of his smoker he always* **examines the combs carefully,** *just before the time for natural swarming.*

If on lifting any of the central frames for inspection, he finds along the edges of the comb **one or more queen cells still capped,** he knows that **a swarming will take place in a few days,** and of course is able to make his preparations.

*Point out that*, thanks to observation, and the sound knowledge that comes from it, **the bee-keeper no longer works at haphazard, or in the dark**, as he once did. He is able to foresee, and make his calculations accordingly.

## IV. ARTIFICIAL SWARMING

1. *Explain that* **a cold rainy season** *frequently* **interferes with the natural swarming.** *The bees huddle together in the hive, and if left to themselves* **will destroy the queen cells,** *and with them all chance most likely of any swarming during the season.*

*Tell that, owing to the uncertainty of our climate, bee-keepers have been driven to try various means of inducing the bees to swarm.*

2. This **artificial swarming**, as it is called, is so easily accomplished that, few bee-keepers now wait for the slower process of leaving the bees to swarm of their own accord, with the chance of failure always possible. **They act for themselves,** and at once, **as soon as the hive shows signs of swarming.**

3. *Describe the process briefly :—*

The first business is to open the hive, and lift the frames one by one for inspection. This is always done **on a fine warm day,** while most of the colony are on the wing, and, of course, with the help of the smoker to subdue those that are in the hive. The manipulator searches, **till he finds the comb on which the queen is resting.** This comb, which no doubt contains brood and eggs, is crowded with **clustering groups of bees.** It is the one he requires for his purpose.

4. He removes it bodily from the old hive, and **places it in the centre of another,** filling up all the rest of the space with **frames containing empty comb,** or **comb foundation.**

He next places the rest of the frames in the old hive close together, and **fixes one with empty comb or comb-foundation on the outside of these**, to take the place of the one which has been removed.

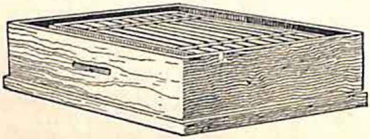
5. Then after covering both hives carefully, he very gently and quietly removes the old one **to a new stand,** and with the same quiet gentleness **puts the new one in its place.**

The bees on the wing return to the old spot, **enter the new hive**, and finding the queen there, **take up their abode in it quite content**, and thus the swarming is quietly carried out in a few minutes.

### V. Hives with Several Storeys

1. *Tell that most hives are now made capable of having* **one or more storeys added to them.** *Show a picture or a sketch of one of these hives.*

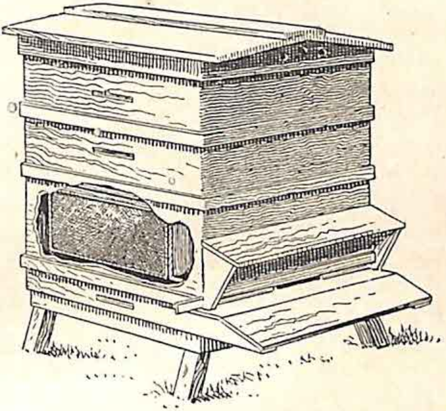
*Show also a picture of one of the* **loose boxes,** *which actually form* **extra rooms in the hive,** *one above another. Explain that these are intended to hold* **extra frames,** *and call attention to the frames and comb in the box.*



2. *Explain their use*:—

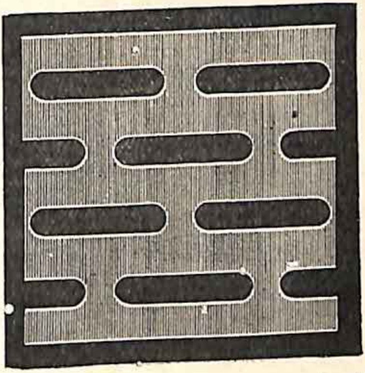
When the bee-keeper finds by inspection that his stock-hive, say two or three weeks before the time for natural swarming, is **crowded with bees,** he removes the top, and **fixes one of these extra loose boxes** filled with empty combs above it.

Some of these empty combs are at once utilised by the workers **for storing honey,** and others for **the queen's eggs,** till all the cells are full.



3. When in course of time **the combs in both rooms are filled** and occupied, he adds a third, and sometimes a fourth.

He usually places, between the second and third



rooms, **a sheet of zinc** with holes cut in it **just large enough to admit the worker bees,** but too small to allow the queen to pass upwards with them.

These upper rooms in the hive thus become simply **a storehouse for honey**; they have **no brood cells.**

### Summary of the Lesson

1. Bees are easily managed, and can be kept under complete control, if they are intelligently handled.

2. In natural swarming the bees leave the hive, and swarm of their own accord.

3. In artificial swarming the bee-keeper changes the frame containing the queen-bee to another hive, which he places on the old stand, removing the old hive to another spot.

4. The smoker enables the bee-keeper to examine the hive, and manipulate the bees as he wishes.

5. Hives with two, three, and four storeys are now in common use.

6. The two upper storeys are used as storehouses for honey. The honey can be removed, and the combs replaced, without interfering with the bees.

## Lesson XXVII

## THE SPIDER

The teacher will require Brown's picture of the garden spider, and a living specimen under a glass; some specimen bees and butterflies; a clasp-knife; a good pocket-lens.

### I. Introduction

1. *Show the living specimen, the picture, or both. The children will of course readily recognise it.*

*Lead them to tell all they can of its favourite haunts, its bloodthirsty habits; its sly crafty method of lying in wait for the flies, and other insects on which it preys; the treacherous net or trap which it makes to catch them—and so on.*

It is a **bold, active, savage** little creature, with a

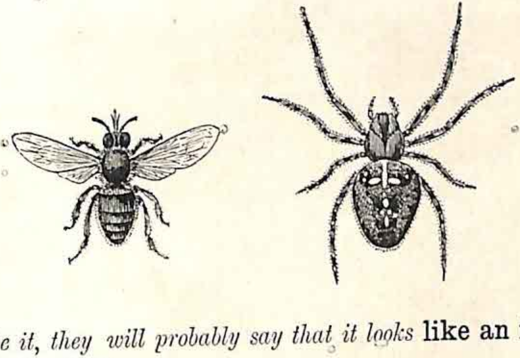
**voracious appetite.**[1] It fearlessly attacks **insects many times bigger than itself.** Most people turn away from a spider with aversion; and yet in spite of its crafty, savage, hungry nature, **we ought to look upon it as a friend.** Can you tell me why?

2. *Remind the children of the ravages committed by insects and their grubs, and lead them to tell that the farmer and the gardener reckon the insect-eating birds among their best friends, because they devour these pests.*

Hence we must class spiders with these birds **as real friends,** whether we like them or not, for **they destroy immense numbers of our insect enemies.**

## II. Structure

1. Two Parts, not Three.—*Let the children examine the dead specimen now, and compare it with the picture. If asked to describe it, they will probably say that it looks* **like an insect without wings.**



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[1] Commenting on the amount which a spider actually consumed, under close observation, during twenty-four hours, Sir John Lubbock (now Lord Avebury) says:—"At a similar rate of consumption, a man weighing 160 lbs. would require a whole fat ox for breakfast, an ox and five sheep for dinner, and for supper two bullocks, eight sheep, and four hogs, and just before retiring, nearly four barrels of fresh fish."

2. *Place it side by side with the bee or the butterfly. Notice that all three are* "**cut into,**" but the bee and the butterfly are **cut into three parts**—the **head, chest,** and **body;** while the spider is cut into **only two parts,** the front part forming **the head and chest all in one,** the big hinder part **the body.**

3. *Let the children feel the dead spider. They find that* its body is **soft and smooth to the touch,** not hard and stiff like the body of the insect.

*Tell that* **the spider,** *like the insect, is* **made up of ringed segments,** *but* the segments **fit so close** that the joinings cannot be seen or felt. They form **a close-fitting, soft, smooth coat.**

**The spider is unlike an insect in shape and covering.**

THE HEAD AND CHEST.—The front part or division consists of the head and chest. The chief features of the head are **the eyes** and the **jaws.**

1. **The Eyes.**—Spiders have **from one to six pairs of eyes,** arranged in two rows, and prominently set in the front of the head, to enable them to see on all sides at once.

*Notice that these eyes are single,* i.e. *they are* **not made up of a mass of very small eyes,** *like those of the insects.*

*Remind the children that the* eyes of an insect somewhat **resemble a blackberry or a raspberry.** The single **eyes of the spider are like little black specks.**

*Tell that the spider's eyes are covered with a* **hard, transparent, horny covering,** *which protects them from injury. Hence they have* **no need of eyelids.**

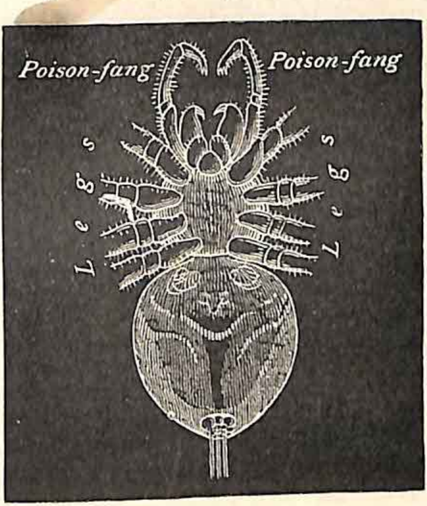
2. **The Feelers or Jaws.**—On the front of the head are **the feelers,** which are really **a pair of sideway-moving jaws,** and each ends in **a terrible claw.**

These are the spider's weapons of attack.

*Point them out in the picture, or make a black-board sketch of them.*

Each feeler is in two parts, and when at rest **the claw folds back in a narrow groove.** *Illustrate by closing the blade of a clasp-knife.*

*Tell that if this feeler is examined through a magnifying glass, it proves to be* **a hollow tube, open at the end.** Through this tube the spider **darts a poisonous fluid into the wound,** which it has made in its victim—a fluid harmless to us, but **fatal to insects.**[1]



1. The Legs.—*Notice again that the head is joined to the chest part without any neck.*

The chest **bears the legs, but never wings. None of the spiders have wings.**

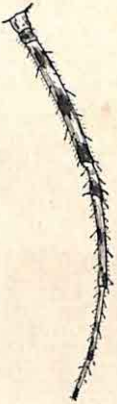
*Count the legs.* There are **eight; not six as the insects have.**

---

[1] There are immense spiders in some parts of the world whose poison is powerful enough to kill small birds.

Spiders always have **four pairs of legs.**

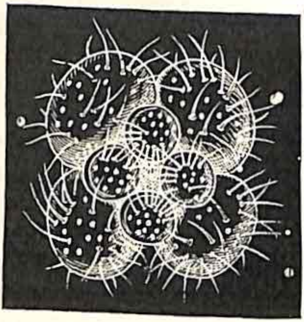
*Call attention to the* **great length of the legs.** *Notice that the first and second pairs are longer than the others, and that each one consists of* **seven joints or pieces.**



2. *Show, either in the picture or with the help of the pocket lens, that* **each foot is a powerful-looking claw.**

*Tell that, having no wings, the spider has to rely upon these* **long legs and powerful claws in pursuing its prey.** *Refer at the same time to its* **agile, nimble movements,** both on its delicate web, and along a wall or a tree, or on the ground.

1. THE BODY.—This, the big hinder part, contains the **organs of digestion,** and **the breathing organs or lungs,** which open in slits on the under side. But besides these organs, it contains **the contrivance for spinning the thread for the web.** All spiders are **clever spinners.**



2. On the under part of the body near the end are a number of **small rounded swellings.**

*Show these in the picture.*

They are **the spinnerets.** Some spiders have **four,** others as many as **eight.**

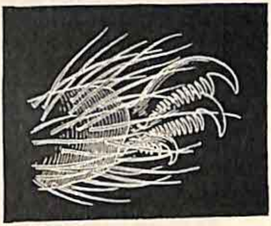
Each spinneret is **perforated like a pepper-box** with about **1000 little holes** or **pores.**

3. The material, with which the spider makes its thread, is a **thick gummy fluid,** which is prepared in a bag (or

gland) inside the body, and **hardens when exposed to the air.**

The spider commences its spinning by forcing out from the bag a tiny drop of this gummy fluid, which **it fixes on some spot,** where it intends to commence work. Then, when all has been **made secure there,** it moves away, **paying out as it goes more fluid from every hole or pore in all the spinnerets.**

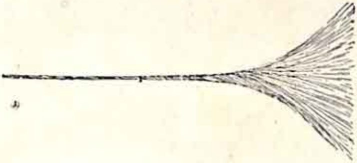
4. The fluid dries and **hardens into a delicate thread** immediately it comes in contact with the air, so that there are now **1000 of these threads** coming **from each spinneret,** or **4000 in all.**



5. *Before proceeding further, pause to notice the spider's* **hind feet,** *which are made* **like combs.** *Show this in the picture.*

*Tell that these combs gather together, and* **twist into a rope, all these thousands of delicate threads,** *as they come from the spinnerets.*

Who has ever seen this rope? It is the single, **silky thread of the spider's web.**



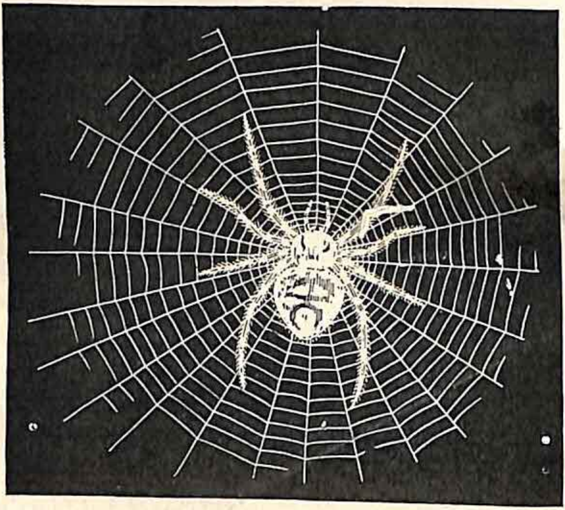
Fancy that fine thread being in itself made up of **no less than 4000 separate strands.**

6. *Remind the children that some kinds of caterpillars spin a sort of silky cocoon, when they are about to enter into the pupa stage. They however* **pass the thread out from the mouth;** *and they* **never weave a web** to catch other insects.

## III. THE SPIDER'S WEB

1. *Lead the children to tell, from their own observation, that the* **garden-spider** spreads its web among the **leaves** and **branches** of trees and shrubs, or across corners of old walls.

This is **the most beautiful of all the webs.** Let us see how it is made, and then you can watch the spider at its work, when you get an opportunity.



2. *Draw a sketch on the black-board, and follow up the work of* **web-weaving** *in the order in which the spider proceeds—* **first stretching** *the stout* **foundation cords,** *then carrying the* **radiating lines** *from point to point across the space, making them meet in the* **centre,** *and lastly running a delicate elastic thread* **round and round in a sort of spiral,** *commencing from the centre. The spider not only runs this thread round, but at every point where it crosses the radiating*

*lines*, **it fixes the two together with a tiny drop of the same sticky fluid.**

3. *Tell of the spider's cleverness in carrying its thread* **across wide spaces.**

It usually spins a very long thread, and then **leaves it hanging from its body,** for the wind to catch it and carry it across the space, and so **lodge it on some twig or wall,** where it clings.

4. The spider **completes its web** in about **an hour.** It then retires to its den close by, to watch the insects which are buzzing all round.

Presently there is a **violent commotion in the web.** An unwary victim has got entangled in the elastic threads, and is **struggling to get free.**

The spider, however, is too quick, for with a sudden rush from its lair, **it throws itself upon its prey,** holds it fast with its **merciless claws,** which are both **spears and poison-fangs,** and then **turns it quickly round and round,** as it **binds its body with more cords.** Thus close bound in every limb—bruised, bitten, and poisoned—it is either **dragged away to the den of the victor** in triumph, to be devoured at once, or **left where it is, in its silky bonds,** as a store for a future banquet.

## IV. OTHER USES OF THE SPIDER'S THREAD

1. Many spiders weave themselves **actual nests** with their silken thread. Our friend, the garden-spider, **makes its den in this way.** It is a snug little room, with walls, roof—**every part of it made of silk from the spider's own body.** In this cosy home it sleeps away most of the cold winter-time.

**It is a winter sleeper.** Why?

The mother spider also **weaves a cocoon** to serve as an **egg-case,** in which she lays her eggs, from 10 to 100 in number.

2. *Remind the children of the insects and their young. Elicit that* **the perfect insect,** *when it has once emerged from the pupa stage,* **never grows.** It lives and dies exactly as it was, when it left the pupa-case.

*Tell that* the young ones, which come from the eggs of the spider, **pass through no such succession of changes.**

They come into existence in their perfect form, **but very small,** and **they grow,** as other creatures do, little by little, **casting their skin time after time** while they are growing.

## SUMMARY OF THE LESSON—SPIDERS AND INSECTS COMPARED

| *Spider* | *Insect* |
|---|---|
| 1. Body in two parts. | 1. Body in three parts. |
| 2. Segments fit close; skin soft and smooth. | 2. Segments easily seen; skin hard. |
| 3. No wings. | 3. Most insects have two pairs of wings; some have one pair; a few have none. |
| 4. Eight legs (four pairs). | 4. Six legs (three pairs). |
| 5. From one to six pairs of eyes. Each eye single. | 5. One pair of eyes. Each eye a cluster of thousands of small eyes. |
| 6. No feelers. | 6. Two feelers. |
| 7. Poison jaws. | 7. No poison jaws. |
| 8. Spinnerets at extremity of the body. | 8. No spinnerets. |
| 9. Breathes through lung-slits in under side of body. | 9. Breathes through breathing-tubes in skin between the segments. |
| 10. Emerges from the egg in its perfect form. | 10. Changes its form three times after it is hatched. |
| 11. The perfect spider grows. | 11. The perfect insect never grows. |

# Lesson XXVIII

## A FISH (First Lesson)

The following articles will be required :—A fresh-caught fish of some sort—a perch will do admirably ; a tumbler of water, a test-tube, the spirit lamp ; some living fish in a bowl of water—gold-fish, minnows, or sticklebacks.

### I. Introduction

*Show the fish and commence as follows :—*

We are now going to study a new class of animals—animals that live all their lives entirely in the water, and **could not live out of it.** We call them **fishes.**

This fish was caught in the river ; some fish live in ponds and lakes ; but most fish are found in the great deep sea. The sea swarms with fish.

*Ask the children to give their reasons for calling the fish an animal.*

It **lives,** and **grows,** and **moves about** ; it **requires food** to keep it alive, and to make it grow.

*Tell that in this lesson we shall learn* **how fishes are fitted to live in the water ; how they breathe ; how they move about** *without legs ;* **how they feed,** *and so on.*

### II. How Fishes breathe

1. We breathe Air.—*Instruct each of the children to place one hand on his chest, and take a long, deep breath, following the example of the teacher.*

*Repeat the process two or three times, so that all may note carefully what happens, and then call upon them to explain—*

What are we doing now ? We are **taking in air.**

Where does the air come from ? It is **all round us** everywhere.

How do we know we are taking it in ? **We can feel it** rush in at our mouth and nostrils. We can feel our chest heave, **as it gets full of air.**

What are we doing now? We are **sending the air out again.**

2. *Elicit that this is what we call* **breathing.** *We could not live many minutes without breathing. We must be* **constantly taking in fresh air,** *and giving it out again after we have used it. We breathe in this way* **even when we are asleep.** *If we could not get air to breathe,* **we should choke or suffocate.**

*Tell that the air we take in at our mouth and nostrils* **passes down into the lungs.** *Show the position of the lungs, and tell that* **cows, pigs, horses,** *and* **birds have lungs like ours,** *and breathe air just as we do.*

*Elicit that a constant supply of fresh air is necessary to purify the blood.*

*Remind the children that slugs and snails, earth-worms, insects, and spiders, as well as other animals, must all breathe air, although they do not all breathe in exactly the same way.*

1. FISHES BREATHE AIR.—We and all the animals around us live and move about **at the bottom of a great ocean of air.** Fishes live and move about **in the water.** But fishes are animals too, and **require air to breathe.** They could not live without breathing, any more than we ourselves could.

How can a fish breathe air, while it is living and moving about in the water?

2. *Tell that the* **water itself contains air.**

Water sucks up air, as readily as a sponge sucks up water. The water of the sea, the rivers, and the ponds is always sucking in air.

*Point out* **the bubbles** *in a tumbler of water, that has been standing for some time. Tell that these are* **bubbles of air.**

So then there is always air in water. **The fish lives by taking in some of this air from the water every time it breathes.**

3. *Heat a little water in a test tube, or a small flask, over the spirit lamp, and call attention to the bubbles which rise upwards*

*to the surface, as the water gets hot.* **These are bubbles of air.**

*Tell that we might easily drive all the air out of a quantity of water by boiling; and if then (after letting it cool) we put a living fish into it, the fish would die at once.*

4. *Explain that* **the fish would die for want of air,** *because, although it lives in the water,* **it must breathe the air that is in the water,** *and not the water itself.*

A cow, a rabbit, a bird—even a strong man—would **die if held under water.** A **fish dies directly it is taken out of the water.** Yet both die from the same cause—**both are suffocated.** One **cannot breathe in the water,** the other **cannot breathe out of it.**

Hence the first thing to puzzle us with regard to a fish is, how it can live and breathe in the water.

1. THE GILLS OF A FISH.—*Produce the fish and proceed to examine it.*

Look at these **long slits** or **openings** on either side of the head, just behind the jaws. Watch, while I lift this one up, and tell me what you see underneath it.

*Point out the* **red fringe-like folds.** *Tell that these are the* **gills.**

*Cut them out with a pair of scissors, and examine them closely.*

Why should they be red? This we could easily learn by examining them under a good magnifying glass. We should then find that they are **crowded with tiny blood-vessels,** which can be clearly seen through the thin skin that covers them. It is the **blood in these vessels** which gives the gills their red colour.

2. *Explain that* **the fish has no lungs** *such as we have—that in fact* **the gills are the lungs of the fish.** *The fish breathes, and takes in air from the water with these gills.*

*Call attention to the fishes, as they swim about in the bowl of water. They are* **constantly opening and shutting their mouths,** *as if they were drinking.*

*Explain that the fish are* **not really drinking**—*that they are not taking in water and swallowing it, as we do when we drink. They take the water into their mouths, but only to* **pass it backwards over their gills,** *and so out again through the slits at the sides.*

3. Now why is all this going on? Every time the fish takes in a mouthful of water, and passes it over its gills, **the gills themselves suck in as much of the air,** as they can get from the water. Our lungs could not do that, but this is the way all fishes breathe. The gills are able to breathe in the water, **because they suck up the air which the water contains.**

### III. FISHES ARE COLD-BLOODED

1. *Lead the children next to compare their own breathing with that of a fish. Remind them that, as we live in an ocean of air itself,* **we can take in plenty of it** *every time we breathe.* **Fishes can only take in a very small quantity of air from the water** *in which they live.*

*Elicit further that the body of a rabbit, a sheep, or a bird* **always feels warm,** *and so do our own bodies. Tell that* **it is the air,** *which is breathed into the lungs,* **that warms the blood** *and the body.*

2. *Illustrate and prove this by picturing a man doing hard work, a boy running, or a horse drawing a heavy load. They all* **breathe hard** *as they work.*

What should we notice at such a time, if we placed our hand on their bodies? We should find them **very hot indeed**—much hotter than usual.

*Explain that, it is* **the extra amount of air** *taken in, that makes the body so hot at those times. It is the air we breathe at all times that makes our bodies warm.*

**These animals as well as ourselves have warm blood and warm bodies;** and their bodies are warmer or colder according to the amount of air they breathe in.

3. *Let one of the children take the living fish out of the water*

*now, and hold it in his hand for a moment—just long enough for him to observe that it is* **quite cold**—*altogether different from the warm body of a rabbit.*

*Explain that* **fishes take in so little air** *by their gill-breathing that, it is* **not sufficient to warm their blood** *or their bodies. They are* **always cold.** *We call them* **cold-blooded animals.**

*Point out next that, as fishes have no bodily heat to keep in, they have* **no need of a thick, warm coat.**

Fishes are never clothed in wool, fur, or feathers, or even with a thick hide. **Their bodies are naked** and **cold.**

### Summary of the Lesson

1. Water contains air. We can drive the air out in bubbles by boiling some water.

2. Fishes breathe under the water, by taking in some of this air.

3. A fish breathes by means of its gills. Animals with lungs cannot breathe under the water.

4. Fishes are cold-blooded animals, because they can only take in a very small quantity of air from the water in which they live.

5. As fishes are cold-blooded, they have no need of a warm covering for their bodies.

## Lesson XXIX

### A FISH (Second Lesson)

Provide for illustration: a small wedge of wood, a piece of wool or fur, and a fresh-caught fish of some kind. A herring with a hard roe should also be got if possible; but if it cannot be obtained (and there is a difficulty about this in many country places) a picture must suffice.

### I. Introduction

*Commence with a few words about fishes as cold-blooded animals.*

*Elicit from the children, step by step, the connection between* *this, and their peculiar mode of breathing in the water by means of gills.*

*Make sure of this important point—that it is only in the warm-blooded animals that thick, warm clothing is necessary.*

Their bodies are made warm **by the abundance of air they breathe in**; thick, warm clothing is needed **to prevent this bodily heat from escaping.**

The body of the fish is not covered with thick clothing, like the body of the rabbit, the sheep, or the bird, **because there is no heat to keep in.**

## II. The Fish and its Covering

1. But there is another reason why fur, wool, or feathers would not be at all a good covering for a fish. Try to find out what I mean.

*Take a smooth piece of wood, and let one of the children move it about in a bowl of water. He does it quite easily. Now cover it with wool or fur, and let him try again. It is not so easy to force the stick through the water now,* **because the thick, woolly covering resists the water.** *Let the child tell what he observes.*

*Tell that the bottom and sides of ships have to be kept clean and smooth, or they would not move quickly through the water.*

Can you tell me now why wool, fur, or feathers would not make a good coat for the fish? Because they would **interfere with the movements of the fish** in the water.

2. *Produce the fish, and call attention to its* **shiny, silvery-looking coat.** *Take up some of the* **loose scales** *on the tip of the finger, and let the children examine them.*

This coat is made up of a multitude of **little, round scales,** which **overlap one another,** and are firmly fixed in the skin in front. The body of the fish is really covered up in **a close-fitting coat of mail.**

3. *Run the finger along the fish from head to tail. Its coat is* **very smooth.** *Rub it in the opposite direction, and* **the scales ruffle up.**

*Point out that, as the fish swims about,* **the water itself presses this scaly coat closer and closer to the body,** *and that helps it in its movements.*

*Let one of the children take the fish in his hand, and ask him to describe what it feels like. It has a* **slimy, slippery feel.**

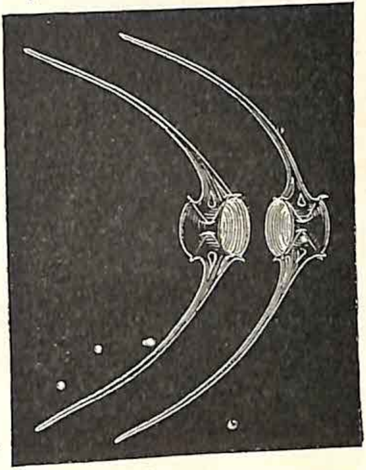
*Tell that fishes are able to send out, and pour over their bodies,* **a sort of slimy oil,** *which also helps them much in their gliding movements through the water.*

## III. How the Fish moves

The Shape of the Body.—*Take a small wedge of wood, and let one of the children force it through the water, first with the base foremost, then the thin edge.*

Which end moves with the greatest ease through the water, and why? The sharp edge **cleaves** or **cuts the water.**

*Now call attention to the fish once more to illustrate the typical form of its body.*



The body, **big in the middle, tapers to a sharp point both ways.** It is like a pair of wedges joined together at their bases, except that all sharp corners are nicely rounded off. The body of the fish is just the shape, to enable it **to cleave its way through the water** with the greatest possible ease.

The Structure of the Backbone.—*Show the backbone of a fish—a perch will do very well for the purpose.*

*Separate some of the vertebræ to show how they are joined.*

*Show that each* **vertebra** *has a* **hollow socket** *on* **both sides,** *and that the bones are* **joined** *by the* **rim** *of one* **socket fitting closely** *to that of the* **next,** *thus forming a sort of* **hollow ball** *between the two.*

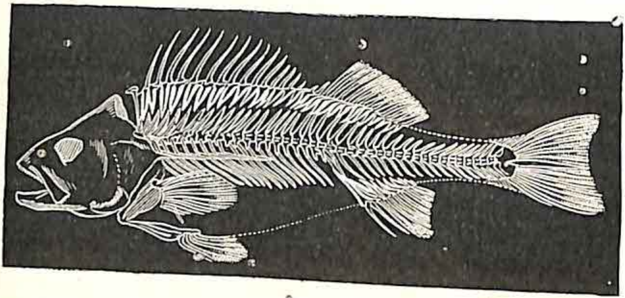
This ball is filled with an **oily fluid,** which helps the **edges** to **move freely** upon each other. The great thing needed in the body of the fish is **flexibility.**

*Show the living fish in the glass globe. Notice the graceful, easy way, in which they twist and turn in the water. This is admirably* **secured** *by such an* **arrangement** *of the vertebræ as we have described.*

THE FINS.—We have thus far noticed the aids, with which the fish is provided to render its **movements easy.** We must now find out how it is that, the fish can **travel** through the **water** at all.

1. *Show the perch once more, calling special attention this time to the* **feathery-looking fins,** *and their position.*

*Notice, in the first place, the* **two very large ones,** *that* **stand up along the middle line of the back.** *Tell that these are known as the* **first** *and* **second dorsal fins,** *and explain that* **dorsal = back.**



*Show next the pair,* **one on each breast, just behind the gills.**

These are known as the **pectoral** or **breast fins.**

**Pectoral = breast.** Just below them **is another pair**; and there is a single one **under the body, near the tail.**

2. But the most important one of all is the **broad, upright fin** at the end **of the body**—that which we generally call the **tail.**

Its proper name is the **caudal fin or tail-fin.**

*Let us find out why we say the* **last** *is the* **most important** *of all.*

*Tell how a boatman sometimes propels his boat* **by sculling**

**with a single oar at the stern**; *and explain that the* **tail-fin is to the fish,** *what the oar is to the boat.*

It is **the tail-fin** that **does all the work** of propelling the fish through the water. Let us find out the use of the other fins.

3. *Point out that* **the back of the fish** *is much* **thicker,**

*and* **more solid-looking than the under part,** *and elicit that, we might naturally expect to find the fish swimming on its back, as that is* **the heaviest part** *of its body.*

*Explain that it would do so, but for the other fins on the breast, back, and belly. These* **balance the fish in the water,** *and keep its body the right side up. Without them* **the fish would roll over** *on its back.*

*Show a dead fish in the water, and point out that it* **floats on its back.**

The reason is that the **fins cannot balance it now,** as they did when it was alive, and the heaviest part of the body naturally takes the lowest place it can in the water.

*Elicit from the children that they have often found some of their sticklebacks dead in the water, and that in every case their dead bodies have* **floated on the top,** *and* **upside down.**

4. *Let the children feel the* **sharp, prickly spines** *in the* **fins of the perch,** *and the little dead* **stickleback.**

*Compare them with the* **fins of the herring, which are soft,** *and tell that most fishes have soft fins of this kind.*

5. *Notice lastly the beautiful appearance of these fins of the perch.* The **first dorsal fin is brown,** with **darker markings between some of the spines.** The **second dorsal fin** and the **breast fins** are **pale brown;** but all the rest are **bright red.**

## IV. How Fishes feed

1. Fishes, as a rule, **feed on one another,** and hunt their prey through the water, as the fierce flesh-eaters hunt theirs on the land.

They are almost all[1] very **rapacious,** and, from the largest to the smallest, prey upon and **devour each other.**

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[1] *N.B.*—The carp family are without teeth, and do not prey on other fish.

This explains why easy and rapid movement is so necessary to these creatures of the water.

At one time they are the **hunters**, at another the **hunted prey.**

2. TEETH.—Let us examine our fish, and try to find out how it goes about its water-hunting.

Where shall we look to find out what we want to know? In its **mouth.**

*Open its mouth and show that it is well provided with* **teeth.**

*Show that the teeth are* **numerous,** *but very* **small;** *they are simply little* **sharp spikes,** *and they all* **point backwards** *towards the throat.*

Fishes have **no teeth** either for **tearing** or **chewing.** Now let us see what all this teaches us.

The teeth must **seize the prey,** and they must also be **strong** enough to **hold** the **struggling, slippery victim fast,** because as the fish has no tearing or chewing teeth, it must **swallow its prey whole,** without waiting to chew it.

## V. FISHES AND THEIR YOUNG

1. Fishes are produced from eggs.

*Open the herring (first seeing that it has a "hard roe").*

*Take out the roe, and tell that each little* **grain** *of the roe is a* **tiny egg,** *which might have produced a young fish.*

What an **immense number** of eggs from one single fish! The eggs, after they are deposited in water by the parent-fish, are called "**spawn,**" and the spawn forms the **favourite food** of many **water animals.** Even the tiny young fishes, that come from the spawn of one kind, feed on the eggs laid by others. Then too these same **young fry** (as the little fishes are called) form the chief food of all others, that are large enough to prey upon them.

This explains why one single fish is made to lay such a **multitude of eggs.**

2. *Tell that the* **eggs of the cod-fish** *float on the* **surface**

*of the sea, till the* **heat of the sun hatches** *them; those of the* **herring** *sink to the* **bottom** *of the* **shallow waters** *in which they are laid, and there stick to the rocks and seaweed.*

Some fishes, that properly belong to the sea, always **swim up the rivers,** to lay their eggs in some shallow place in the **fresh water.** The **smelt, salmon,** and **trout** are members of this class.

### SUMMARY OF THE LESSON

1. The close-fitting coat of smooth overlapping scales helps the fish in its movements through the water.

2. The tail propels the fish through the water. The fins serve to balance the body.

3. Most fishes feed on other fish. They swallow their prey whole. The teeth are made for seizing and holding, not for chewing.

4. Fishes are hatched from eggs. The roe of a single fish contains an immense number of eggs.

## Lesson XXX

## THE FROG

### OUTDOOR OBSERVATION

1. *DURING one of the rambles in early spring (about the middle of April) take the class to some pond in the neighbourhood, and endeavour, as though by accident, to stumble over a frog—there are sure to be plenty about.*

*Make a show of trying to catch it. Notice how nimbly it leaps away, making in all probability for the water, and at last springing clean into it. Watch its graceful movements under the water. It is quite as much at home there as on land.*

*Compare it in this respect with fishes on the one hand, and birds and four-footed animals on the other.*

How is it that **this curious animal can live equally well in the water as on land?**

2. *Remind the children in the next place that we lose sight of the frogs altogether during the winter.*

They seem now like old acquaintances come back. Where have they been?

*Explain that these animals, like the squirrel, the bat, and the snail, are* **winter sleepers.** *Lead the children to tell where some of those winter sleepers take up their quarters, and settle themselves for their long sleep.*

The frog wants **a safe comfortable sleeping-place** too. Where do you think it makes its winter bed?

3. *Rouse the curiosity of the children, and then tell them that* **it scoops out a hole in the mud at the bottom of the pond,** *and sleeps there.* What a strange bed to sleep in.

The frogs, which we see now, have not been long up from their sleeping-places. As soon as winter is over, **they scramble out of their mud beds, lay their eggs at the bottom of the pond,** and then come up to the top to enjoy themselves, and look about for food.

4. *Call attention to the* **masses of dirty-looking jelly,** *which are to be seen* **floating about** *on the surface of the water, or* **clinging to the weeds** *by the side of the pond.*

*Collect some of this jelly with a hand-net, and put it, weeds and all, into a bowl, or a large bottle of water, to carry back to school.*

5. *Point out* **the little black specks** *in the middle of the jelly.* **These are the eggs.**

The mother frog lays them in the mud at the bottom of the pond, and **takes no further care of them.** But **the jelly,** with which each egg is covered, **swells up** in the water, and **becomes so light,** that in a short time **it rises and floats on the surface,** where the **eggs are hatched by the heat of the sun.**

*Set the boys now to search for a good specimen frog, and when one has been secured, put it in a small wire cage with a sod of wet grass at the bottom, so that it may be carried back to school, with the eggs in the bottle, for further observation.*

## LESSON IN SCHOOLROOM—HABITS AND STRUCTURE

*Take the earliest opportunity that offers in school of following up these observations with a lesson, to show that* **the habits of this curious animal are dependent upon its structure.**

*With the help of the living specimen, a large bowl of water, and Brown's picture of "Frogs," proceed as follows:—*

### I. MOVEMENTS

1. A LEAPING ANIMAL.—*Produce the living frog in the cage, and commence by calling attention to the* **great length and size of the hind limbs,** *as compared with the* **short fore-legs.**

This gives the creature an **awkward ungainly appearance,** as it sits there in its favourite resting position **on its haunches.**

*Point out that no animal with legs of unequal length could walk and run, as cats and dogs, horses and cows do.* **The frog was not meant to be a walking animal.**

2. *Compare with the* **grasshopper,** *the* **rabbit,** *and the* **hare.**

*Elicit that all these move about from place to place by* **leaping or jumping.** *Their* **hind-legs are much longer and stronger** *than the fore-legs.*

The frog in like manner was meant to be **a leaping or jumping animal.**

*Let one of the boys now take the frog out of the cage, and put it on the floor. Watch it as it moves about, and observe that* **every movement, short or long, is a leap on those strong hind-legs.**

A SWIMMING ANIMAL.—*Put the frog into the bowl of water now, and call upon the children again to observe its movements.* **It swims by kicking out vigorously with those long hind legs.** They seem to do all the work.

*Take it out of the water now, but before putting it back into* *the cage, point out that there are* **five very long toes on each hind foot,** *with* **a web or skin between them.** *Compare with the webbed feet of a duck.* **The frog's hind feet are webbed to fit it for swimming.**

*Notice that the* **front paws** *have only* **four toes,** *which are much shorter, and* **not webbed.**

## II. BREATHING

1. LUNGS.—*Call upon the children to place their hands on their own chests, and take a deep breath. While doing so they feel the chest heave and fall.*

*Elicit that the lungs are inside the chest, and that the chest itself is a sort of box,* **with the ribs all round it like hoops round a barrel.**

*By keeping their hands on their chests the children will notice that these* **ribs are constantly rising and falling** *without any effort on our part.*

2. *Explain that :—*

(*a*) *When they rise* **they make more room in the lungs,** *and* **air then rushes in** *through the mouth and nostrils to fill them.*

(*b*) *When they fall* **they make the chest and the lungs themselves smaller,** *and so the* **air is driven out** *again.*

We, and most lung-breathing animals, breathe in this way, without any trouble to ourselves. We are scarcely conscious of it, while we are sitting still.

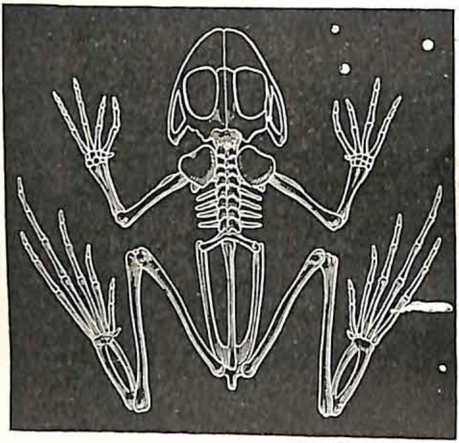
3. *Now show the skeleton of the frog in the picture. Notice that* **this animal has no ribs.**

Its lungs cannot be expanded to take in air, in the same way as ours are. **Yet it must breathe as well as other animals.**

*Observe the frog in the cage. It sits there on its haunches with its mouth closed, but* **it seems to be constantly swallowing.**

4. *Explain that* it is really swallowing—**it is swallowing air, gulp after gulp,** just as we swallow our food and drink. **This is its way of breathing.**

It closes the mouth, sucks up a quantity of air through the nostrils, and forces each draught down into the lungs with a special effort.



1. SKIN.—*Tell that, with all its sucking and swallowing, it cannot get enough air in this way, and then proceed to show how it is assisted by the skin.*

**The skin is very porous:** it will absorb water like a sponge, and **so long as it is kept moist it will absorb air too.** The frog **breathes through its moist porous skin,** as well as with its lungs.

2. It lives in the water without discomfort, because although it cannot breathe under water with its lungs, **its skin is constantly taking in air from the water itself.** The skin has to do the entire work of breathing then.

*Remind the children of its winter sleeping-place at the bottom* *of the pond. No lung-breathing animal could remain there asleep during the long winter months, for all animals must breathe in some way, sleeping or waking.*

The frog, however, **closes mouth and nostrils,** and goes off to sleep in its wet bed of mud, **leaving its skin to do the breathing work.**

3. *Observe that, uncomfortable as it seems to us, that bed of wet mud is the very thing necessary to the frog.*

If it were put into a **nice dry place,** its **skin would shrink** and **become stiff like parchment; its body** would grow **thin and wretched-looking.** Indeed it would die if left there long; but if instead of leaving it to die, we put it into a wet place, it would rapidly recover. The skin requires plenty of water **to keep it in a moist condition,** and then it is able to do its breathing work.

But without moisture **the skin would shrivel up,** and so **close the pores,** and then the skin-breathing would become impossible.

*Deduce from this the reason why, in hot dry weather,* **frogs** *in the garden always* **hide away under the broad leaves of cabbages** *and other large plants, or* **in some cool spot;** *and why also they always* **make their homes near the banks of ponds and ditches.**

1. COLD-BLOODED.—*Have the frog taken out of the cage again now, and let the boys handle it. They find that* **its body is cold.** *Call upon them to explain this, step by step, comparing it with the body of the fish, as follows:—*

*Picture men or horses doing hard bodily work. They breathe heavily and more rapidly at such times, i.e.* **they take in more air than usual.** They soon become very hot.

**It is the air, which is taken in, that gives heat to the blood and the body.**

2. *Explain that, with lungs and skin too,* **the frog takes in so little air** *that, it is not enough to warm the blood.* Hence **its blood is always cold.**

The frog's body is cold **because its blood is cold.** The frog, like the fish, is **a cold-blooded animal.**

*Lead them to tell further, in connection with this that, as the frog has no bodily heat to keep in, it is* **not provided with a warm coat** *of fur or wool. It has* **a naked skin,** *which* **always feels cold and clammy** *to the touch.*

3. *Remind the boys, in the next place, that even in the hot weather, when we go for a swim, our warm naked bodies soon get chilled in the water.*

**A warm-blooded animal,** with a naked skin, **would not be able to live in the water,** much less to sleep for months together at the bottom of the pond.

The frog is fitted for this life, **because, its blood being cold,** it does not feel the cold of the water.

## III. Feeding

1. *Return to the picture now, and proceed to describe the frog's head.*

It is very **large and broad,** and somewhat **triangular** in shape. It is **set square on the shoulders** without any neck.

*Notice the* **extremely wide mouth,** *and the* **enormous goggle eyes,** which, with their yellow edges, look like a pair of gold-rimmed spectacles.

*Notice too that these great eyes are* **very prominently set in the head,** *and deduce from this that there must be some* **sharp look-out work** *for them to do.*

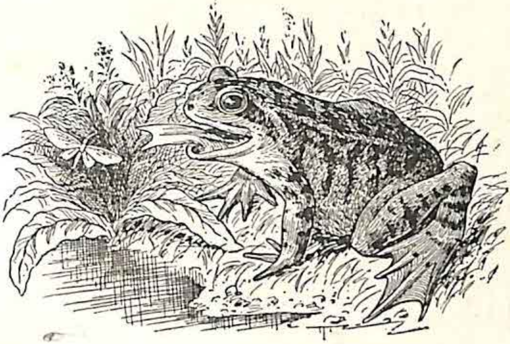
2. *Show the dead specimen now, and let the children feel inside its mouth for the teeth.*

The **upper jaw** contains a row of **sharp spiky teeth,** all of which **point backwards** like the teeth of a fish. There are **no teeth for chewing or tearing purposes;** and **no teeth at all in the lower jaw.**

3. *Next call attention to the tongue. Explain that the frog's tongue, instead of springing from the back of the mouth, as the*

*tongues of most animals do,* **has its root in front,** *and actually* **points backwards towards the throat.**

The frog is able, when it wishes, to **throw its tongue**



**forward,** and then the tip reaches a long way beyond the mouth.

*Tell that the frog is* **an insect-eater,** *and it uses this great fleshy tongue as its* **fly-trap.**

4. *Explain too that it never attacks its prey, when they are perfectly still. It catches the insects only when they are on the move.* **Hence the need of those great prominent eyes.**

*Picture the frog lying motionless in wait for its prey, till a fly comes flitting by within striking distance, when with the rapidity of lightning* **the tongue is darted forward,** *and carried back to the mouth again.*

*But the fly has gone with it, and is swallowed by this time, for the tongue rarely misses its aim, and* **it is covered with a thick slimy matter as sticky as bird-lime.**

5. The frog varies its insect food with **slugs, grubs,** and **snails.** It is therefore **one of the gardener's best friends.**

It is also **very partial to worms,** and it is when the frog is **trying to swallow larger prey** than mere flies and grubs—such as an earth-worm—that **it finds its row of teeth useful.**

*Describe the frog in the act of swallowing a worm. It pushes the worm into its mouth with its fore paws, while its teeth hold their prey in spite of its struggles to get free.*

### SUMMARY OF THE LESSON

1. The frog is a leaping animal. Its hind-legs are longer and stronger than the fore-legs.

2. The hind paws are webbed for swimming.

3. The frog has lungs, but no ribs. It breathes by sucking up air through its nostrils.

4. The frog breathes through its moist porous skin.

5. If the skin gets dry the pores close up, and the skin-breathing cannot go on.

6. The frog is a cold-blooded animal; it has a naked skin.

7. The frog's tongue is its fly-trap.

8. The frog feeds upon insects, slugs, grubs, and snails. It is the gardener's friend.

## Lesson XXXI

## LIFE-HISTORY OF THE FROG

Brown's picture, and some living tadpoles in a bowl of water should be provided for illustration.

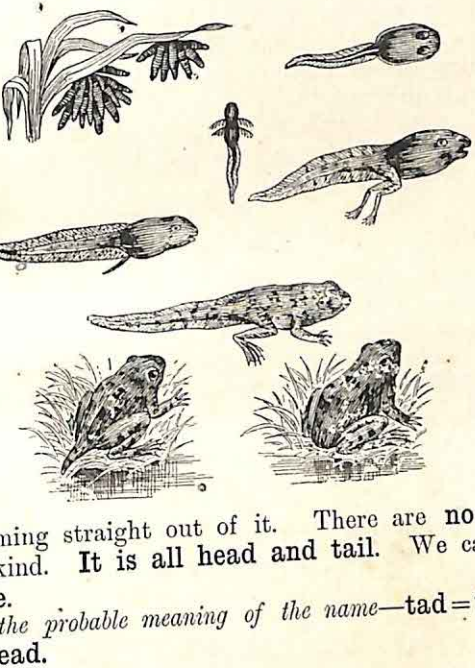
### I. FROM EGG TO TADPOLE

1. *FROM what they now know of the nature of the frog, the children will be prepared to take an intelligent interest in the jelly-like mass of eggs, which they brought from the pond.*

*As they watch the eggs from day to day, it will readily be seen from the first that certain changes are taking place, for* **each egg gradually increases in length.**

*This goes on for* **about ten days** *from the time the eggs* *were laid. Then at last* **the egg is seen to burst,** *and* **a tiny thing forces its way out.**

2. *Look carefully at the little creature that comes from the newly-hatched egg.* It is not a frog: it is altogether unlike a frog. It has **a large head,** and there is **a sort of tail,** coming straight out of it. There are **no limbs** of any kind. **It is all head and tail.** We call it a **tad-pole.**



*Tell the probable meaning of the name*—**tad = tailed; poll = head.**

3. *Notice that at first the tadpoles cling to the floating weeds, and for some days remain fixed in this way.*

They seem to be **hanging on with their mouths;** but if we examine them closely, we find **they have no mouths.** In the place, where we should look for the mouth, they have **a pair of suckers.** They use their suckers for the very purpose of clinging to the weeds in this way.

## II. Fish-like Form

1. Tail for Swimming.—*Let the next inspection be put off for a few days, when it will be seen that important changes have taken place.*

The tadpoles have grown much bigger. They have now **a very long flat waving tail.**

They are no longer fastened to the weeds; they are **swimming about** in the water, and they **make use of their tails in swimming,** just as fishes do.

*Explain that they are* formed to live in the water; *if we took them out of the water,* they would die. **The tadpole is now very like a fish.**

Gills like a Fish.—*Notice too that its suckers have disappeared, and that* it has **a wide fish-like mouth** now.

*Point out in the next place* the **three pairs of pink fringes** on each side of the head.

*Tell that these fringes are* **gills, like the gills of a fish.**

Tadpoles, like fishes, have no lungs as we have. **They have gills instead,** and gills are fitted for breathing in the water. **They could not breathe out of the water;** our lungs could not breathe in it.

2. *The next thing to notice is that the tadpole has its mouth placed, not in the very front of the head, but rather under it.*

*Explain that this mouth is specially* **fitted to nibble off the soft shoots of the water-plants,** *upon which it feeds —for* **it lives entirely on vegetable food.**

*The children should now compare the tadpole with the parent frog, in its general appearance, its mode of breathing, its food.*

Why did the mother frog lay her eggs in the water?

## III. From Tadpole to Frog

*The tadpole continues its water-life for* **four, six,** *and sometimes* **eight weeks,** *according to the condition of the* *weather—longer in a cold backward springtime, than in a warm bright one. But meanwhile very important changes are going on, and the children should note these changes one by one, as they take place.*

1. LEGS APPEAR.—After a time, as the tadpole feeds and grows, **two little lumps begin to make their appearance,** one on each side of the tail, near its root. These lumps grow bigger and bigger, and as they grow **they take the form of a pair of hind legs.**

*Watch the development of these legs, and note that while they have been growing,* **the great tail has been wasting away** *little by little.*

By the time these hind legs are fully formed, **the tail tumbles off entirely** in a shrivelled-up state.

2. *But observe that, while the hind legs are forming,* **two other lumps begin to show,** *one on each side of the body, nearer the head. Let the children watch these from time to time.*

Like the others they grow rapidly, and at last **force their way through the skin,** taking the form of the **two fore-legs and feet.**

3. *It is difficult to know what to call the creature now. It is scarcely a tadpole, for its long waving tail has entirely disappeared; it has* **four legs and feet** *fully developed; its* **head and body have grown large and broad;** *and its* **mouth,** *which was some distance under its chin (so to speak),* **is now quite in front of the head,** *and has grown* **large and broad.**

*Notice too that the eyes have forced themselves outwards. They begin already* **to stand out prominently** *like the eyes of the frog.*

GILLS DISAPPEAR.—*Explain that other changes have been going on all this time—some of them not so easily noticed.*

As the body grows, **the gills shrivel up,** and become smaller and smaller, while **lungs begin to form inside** to take their place.

By the time the four limbs are fully developed, and the creature has taken its frog-like form, the **last vestige of the gills disappears.**

It then begins to find breathing under the water a difficult matter, and after making its way by instinct to the surface, it finds **it can breathe air through its lungs.**

IT LEAVES THE WATER.—*The rest of the story is easy to tell :—*

It at once leaves the water, and commences a new kind of life in the green fields—**a frog at last.**

It soon begins to feel the pangs of hunger, but it has now no appetite for the green vegetable food around. It has a craving for **animal** food.

It has become a flesh-eater, and a very greedy flesh-eater too. It still continues to grow, as a frog, and as it grows it **sheds its skin** from time to time, tearing it off with its paws and swallowing it every bit.

Fancy a boy dragging off his coat and swallowing it, when it got too small for him.

### SUMMARY OF THE LESSON

1. The frog's eggs are hatched by the sun; tadpoles come from the eggs.
2. The tadpole has a head and a long body, but no limbs. It is very like a fish.
3. The tadpole breathes through gills. It has no lungs.
4. The tadpole feeds on the plants that grow in the water.
5. As it grows, the tail falls off, two pairs of legs form, the gills shrivel up, and lungs take their place.
6. The fully-formed frog is a flesh-eater, not a vegetable feeder, like the tadpole.

# Lesson XXXII

## FROGS, TOADS, NEWTS, LIZARDS

### (A COMPARISON)

The teacher should, wherever possible, be provided with actual living specimens for illustration, in addition to Brown's pictures of these animals.

### I. TOADS AND FROGS

*SET the frog and the toad side by side, and call upon the class to look well at them, and compare them.*

1. GENERAL APPEARANCE.—*They will observe that :—*

(*a*) The toad is like the frog in build and general appearance ; it is **frog-like** in shape, but **larger.**

(*b*) The upper part of the toad's body is **covered thickly with little swellings,** which look like **warts** or **pimples.** But the **frog's skin is smooth.**

(*c*) The colour of the frog is either **greenish-yellow,** or **brown** ; but the toad's warty skin is **dark-grey** with **olive green marblings.**

(*d*) Both are yellow on the under parts, but the **toad's yellow belly** is **spotted** with black.

2. MOVEMENTS.—*Notice and compare the movements of the two animals, when they are placed on the floor.*

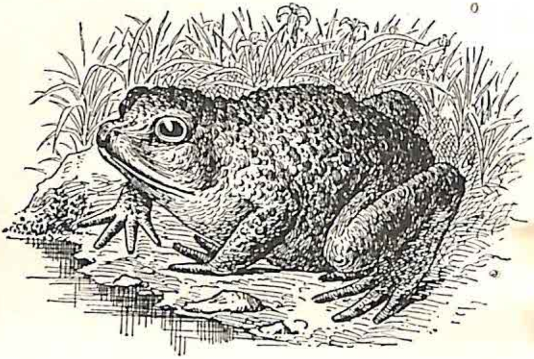
The toad moves about with a **slow crawling gait.** It **never leaps.**

*Point out that it is* **more clumsily built** *than the frog.* Its **body** is **heavier,** and its **legs** are **shorter.** The hind-legs in particular were **not made for leaping.**

*Compare it with the frog in this respect.* **Every movement of the frog is a leap** on its long hind-legs.

*Notice next that the toad's hind feet are* **not fully webbed.** *Compare them with the hind feet of the frog; and elicit that* **the toad,** unlike the frog, **could not have been intended for a water-life.**

*Tell that* it is **not a good swimmer**; it **rarely takes**



**to the water,** except in the spring **to lay its eggs.** It is **a land animal.**

*Lead the children to tell, from their own observation that,* it hides during the day in damp spots, and comes abroad after sunset.

3. FOOD.—*Tell that the toad* has no teeth at all in either jaw. It differs from the frog in this; but its tongue is exactly like the frog's tongue, and is used in exactly the same way as a fly-trap.

*Explain that, like the frog, it* **lives upon insects, slugs, and worms,** and has the same habits of feeding. Like the frog, too, it is one of our friends, for it is most useful in devouring vermin, that would destroy our plants in the garden.

4. LIFE-HISTORY.—*Tell that* the toad, like the frog, **begins life as a tadpole,** and **passes its tadpole stage**

in the water. But the young toads **do not leave the water** in their perfect form **till autumn.**

*Notice that* it is **a winter-sleeper**; but, unlike the frog, **it does not sleep in the muddy bed** at the bottom of ponds and ditches, for it **could not live and breathe under water** all through the winter. It **scoops out a hole** for itself **in the ground,** or **under some piece of rock,** and hides and sleeps there.

*Say a word or two now in exposure of the popular error, as to the venomous nature of the toad, for certainly no creature has been more cruelly treated in the past through ignorant superstition.*

It is **by no means venomous.** It is **practically harmless,** although it certainly does **throw out an unpleasant-smelling liquid from its skin,** when it is alarmed.

This is enough **to drive other animals away from it**; few dogs will meddle with a toad. But it is wrong to say the toad is venomous because of that.

## II. Newts and Frogs

*Produce the newt now, and proceed to compare it with the frog and the toad, as follows:—*

General Appearance.—It has a **long slender body,** an **extremely long tail,** and **four legs of equal length.**

*Compare it in all these respects with the frog and the toad, and deduce that:—*

**The toad** in general appearance is **a frog-like animal; the newt is quite distinct from both.**

*Tell that it is* a **perfectly harmless** little creature, **pretty** in appearance, and **graceful** in its movements. The **male newt** is known by the **beautiful wavy crest,** which extends along the middle of the back.

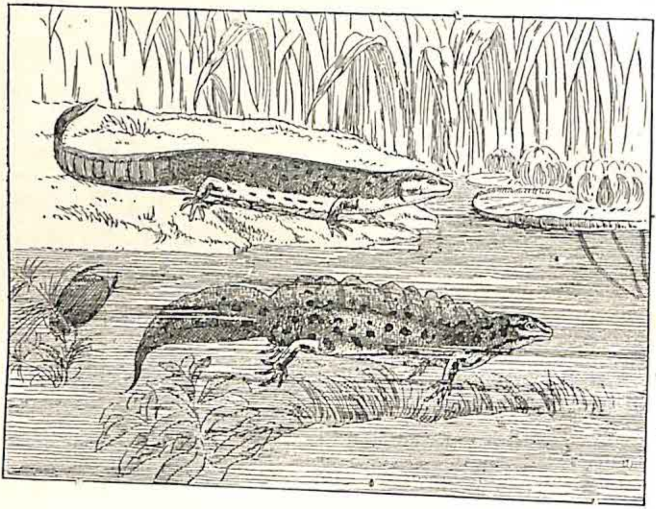
Newts are also known as **efts, effets,** or **evats** in certain parts of the country.

1. Movements.—*By referring once more to the form of*

*the legs, lead the class to tell that such an animal was* **intended for walking and running.** It could not be a leaping animal like the frog.

*Place it on the ground now, and let the children note its movements.*

It **walks** and **runs**; but **never leaps.** Its slender graceful body makes it **very nimble.** *Compare with the* **clumsy body,** *and* **awkward movements, of the toad.**



2. *Place it in a bowl of water now, and watch its movements there.*

It **swims easily**, and is as much at home in the water as out of it.

*Observe that* it **uses its long tail,** as its principal means of movement in the water. The **frog has no tail**; it uses its **hind feet as swimming paddles.** The **newt's feet are not webbed; it propels itself** through the water with its **long flat tail.** *Compare it with the long flat waving tail of the legless tadpole.*

*Show from this that the newt, like the frog,* **is fitted to live in the water as well as on land.**

It lives in and near ponds and ditches, because **it feeds mostly on tadpoles and worms.** It is another of the winter-sleepers. Why?

3. *Notice that all this time the newt in the bowl of water, although swimming about quite at its ease, does not remain long below the surface.*

*Explain that it is* a **lung-breathing animal,** but that, unlike the frog, **its skin is not adapted for breathing purposes,** to assist the lungs in their work. The frog under water breathes through its porous skin; the newt cannot breathe through its skin. Hence it **cannot remain under water** for any length of time. **It must come up to the surface to breathe.**

*Note that after swimming about below, it seems to rest on the surface to get breath again.*

1. LIFE-HISTORY.—*Tell that newts, like frogs and toads,* **commence life as tadpoles,** and pass the **tadpole stage in the water.**

*Describe the great care which the female newt takes in laying her eggs.*

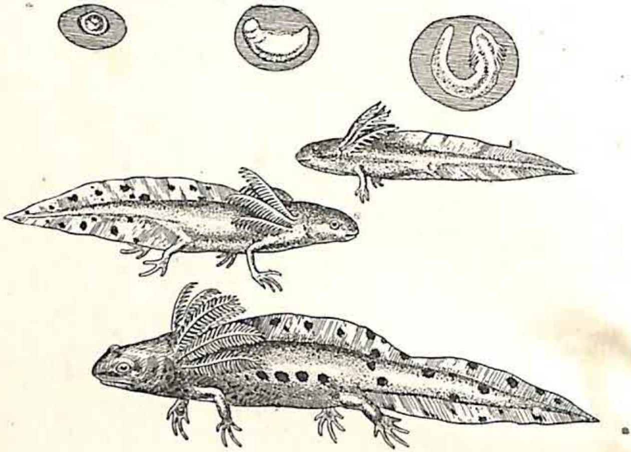
Before depositing the eggs in the water, **she wraps them one by one in a leaf,** which she rolls up into a ball with her fore-paws. This is probably done **to protect them against possible enemies,** which might devour them.

2. *Tell that, during the changes from tadpole to newt,* **the fore-legs appear first**; the hind-legs later on. In the frog **the hind-legs** are the **first** to make their appearance.

*Note too that* **the tail remains, and grows with the rest of the body.** The tadpole of the frog loses its tail as the legs appear.

At first **the fringe of pink gills** can be plainly seen **outside the neck,** as in the other tadpoles; but later on

**the gills vanish,** and **lungs form.** Then it can no



longer breathe under water; **it must come up from time to time to breathe.**

## III. Lizards

*These pretty harmless little creatures are so familiar to all country children, and so similar in general appearance to the newts, that it would be scarcely possible to avoid comparing the two now.*

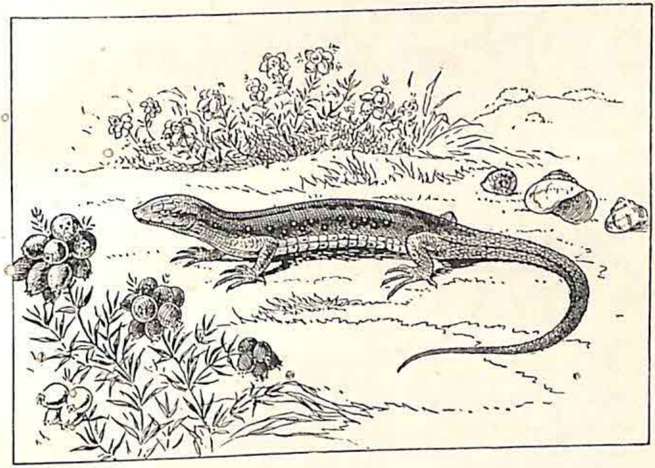
The Common Sand Lizard.—*Produce the living specimen, if possible, and lead the children to describe its general appearance, side by side with the newt*—**the long slender body, four legs of equal length,** and **a long tail** which is about **twice the length of the head and body** together. From the nose to the tip of the tail it measures **about seven inches.**

The **male is green** above, with **a dark streak** along the middle of the back; the **female** is **grey or brown.** Both are **yellow on the under parts.**

1. Haunts and Habits.—*The boys will no doubt be able to tell where this little creature is to be found.*

Its favourite haunts are among the grass and heather **on the heaths and uncultivated grounds.** It loves to lie **basking on a sunny bank,** but it is extremely agile, and if disturbed will dart away among the grass, **twisting and turning with such rapidity** that it is not easily caught.

*Tell that sometimes, if roughly seized, it will* **snap off its tail,** *as clean as we could break a thin splinter of glass.*



2. It **feeds on insects,** and its agile movements are a great assistance in capturing its prey. Like all the insect-eaters it is **a winter-sleeper,** and it makes its winter nest in **a burrow beneath the roots of some tree or shrub.**

It lays its eggs (twelve or fourteen in number) **in a hollow in the sand,** and leaves them to be **hatched by the heat of the sun.** The young ones emerge from the eggs in the perfect form. **They do not pass through any succession of changes,** like those of the frog, toad, and newt.

3. In many parts of the country another lizard, about the same size as this one, is very common. It is of a **yellowish-brown colour,** and **the male is a bright orange red on the under parts.**

It is usually found near ponds and streams, for unlike the common green lizard, it is **fond of water** and is **a splendid swimmer.**

The young of this creature are **not produced from eggs** at all. **They are born**[1] **alive,** from three to six in a litter.

Lizards do not belong to the same family as frogs, toads, and newts. They are **reptiles.**

### SUMMARY OF THE LESSON

1. The toad is bigger and more clumsily built than the frog. It is not made for swimming, and on the land it is slow in its movements.

2. It has no teeth; it feeds on insects, slugs, and worms.

3. The toad is not venomous; it is perfectly harmless.

4. Newts or efts are fitted to live in the water as well as on land. They use their long tail in swimming. They cannot breathe under water.

5. They are very nimble in their movements out of the water.

6. They are quite harmless.

7. Frogs, toads, and newts all begin life as tadpoles.

8. Lizards do not belong to the frog family. They are reptiles. They do not begin life as tadpoles. They are quite harmless.

9. Frogs, toads, newts, and lizards are all winter-sleepers.

## Lesson XXXIII

## THE COMMON GRASS-SNAKE

*SNAKES are universally held in such aversion by old and young alike, that it has been deemed advisable to alter the usual mode*

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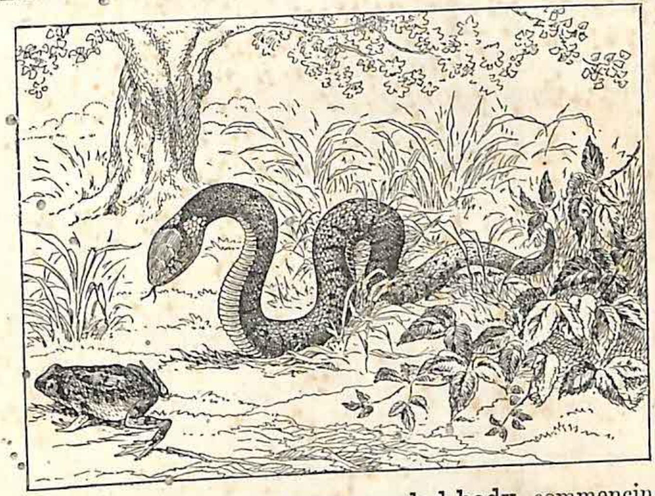
[1] Hence this one is known as the viviparous lizard.

*of procedure in dealing with them here. The class lesson should come first, and with the help of pictures and specimens it will have the effect of removing ignorant prejudices; then when the children have learnt something of the real nature of the animal, they may (where opportunity offers) be taken by the teacher on one of their rambles, to study it more closely in its natural haunts.*

*Brown's pictures of "Snakes" will be required, and where possible a tamed living specimen of the common snake should also be provided for the lesson.*

### I. General Description

1. *Show the picture of the* **Common Grass-Snake,** *or better than that, where it is possible, the tamed living specimen. Let the children note for themselves the general appearance of this new form of animal*—its **long rounded body,** commencing with an **oval, somewhat tapering head** in front, and ending in a **slender pointed tail** behind—the **entire absence of limbs** of any sort—**the peculiar covering of overlapping scales,** and so on.



*Tell its name, and explain that* **it is perfectly harmless,** *wherever it is met with. This snake is often caught and* **tamed as a pet.**

2. *Before proceeding further, call special attention to the colour and peculiar markings of the body, for these are the points which, at a glance, distinguish this harmless snake from the poisonous viper.*

The general colour of the **back and sides** varies from **brown to olive-green;** the **under parts are bluish grey.** There is **a yellow splash on either side of the neck,** just behind the head, which gives it its other name—**Ring Snake;** and **rows of black spots** show up plainly on the **back and sides.**

3. *Measure this snake. It is probably* **between two and three feet in length.** *It rarely exceeds three feet.*

*Tell that to-day we are going to learn how these* strange-looking animals are formed, and how far their **habits depend upon their structure.**

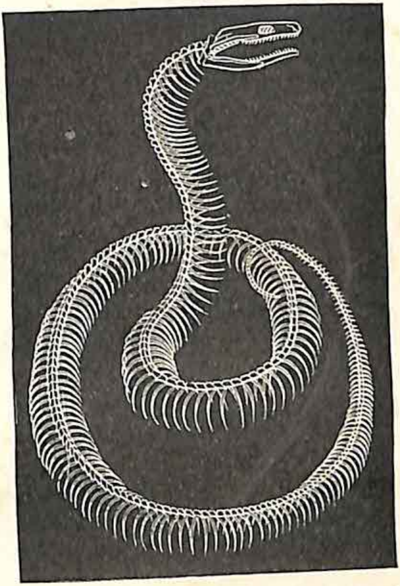
### II. Structure and Movements

1. The Backbone.—*Show the skeleton—an actual one if it can be obtained, but failing that the diagram, or a black-board sketch.*

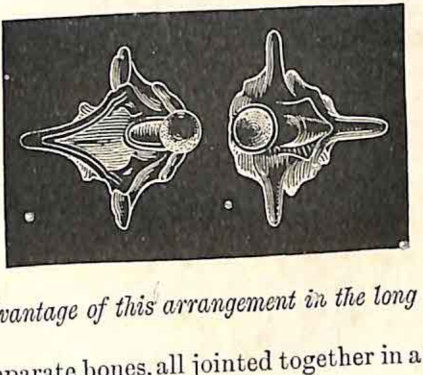
*Call attention to the* **backbone,** *which stretches through the whole length of the body from head to tail. Point out that it is really* **a string of distinct and separate bones.** They are jointed together in a very wonderful way, for a very wonderful purpose.

2. *Show, either with the bones themselves, or with the help of the diagram, that* each bone has in front **a kind of projecting knob,** like **a round ball,** while behind there is **a cup-like hollow or socket,** just large enough **to hold one of these knobs.**

The whole string of bones is held together by the ball of one bone fitting into the socket of the bone in front. We call these **ball-and-socket joints.**



3. *Show how such a joint works, and lead the children to discover the advantage of this arrangement in the long body of the snake.*



These separate bones, all jointed together in a long string by ball-and-socket joints, **make the body extremely flexible,** and enable the animal to **bend and twist easily** in all directions.

1. THE RIBS.—*Call attention now to the* **short curved tapering bones,** *which are arranged* **in pairs,** *on either side of the backbone.* These are **the ribs. The skeleton is all backbone and ribs**—there is no sign of a limb bone.

*Remind the children that our own ribs pass quite round the body, like the hoops round a cask. Compare with the* **ribs of a frog,** *and let them tell the reason for the difference.*

2. *Point out that here again we have an animal* **with ribs, which do not pass all round the body. The ends of the snake's ribs are free.**

We must find out the purpose of this.

*Notice that* **each pair of ribs** come from **one separate bone** in the central string; *and explain that the* **ribs are all jointed** to these bones by **ball-and-socket joints.**

*The children will, of course, readily tell the rest:*—The ribs, by means of this arrangement, are enabled **to move backwards, forwards, sideways**—in every direction.

1. THE SCALES.—*Refer once more to the outer covering of* **hard horny scales.**

*Notice that each scale* partly overlaps the one behind it, so as to leave **the hinder edges of all of them free.**

*Examine those on the under side of the body more closely, and let the children observe that* **these are larger than the rest.**

*Tell that these are all* **joined with the lower free ends of the ribs by means of strong muscles.**

2. With these scales on the under side of its body, the snake moves about, and it can be very rapid in its movements when it wishes.

The ribs, as we have seen, can be moved forwards and drawn backwards, and as **each rib is connected with one of the under scales,** it carries that along at the same time.

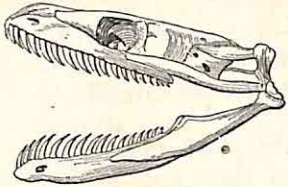
When the snake therefore wishes to move, it first **advances the ribs,** and with them **the under scales.** These take **a firm hold** of the ground or tree on which they rest, and the **body is drawn forward** with a **gliding, creeping, serpentine movement.** They are like an **immense number of feet.**

3. *Explain that the very name* **snake** *comes from a word, which means to* **creep** *or* **glide.**

The snake has **neither legs for running, paws for climbing, nor fins for swimming.** Yet it can **move rapidly** and easily about on the ground, **leap tremendous distances, climb trees,** and even **swim in the water**—and all **with these wonderful ribs and scales.**

### III. Structure and Habit of Feeding

1. Teeth.—*Turn once more to the skeleton now, calling attention this time to the* **teeth.**



*Note that the teeth in both jaws are* **small** *and* **sharp pointed,** *and that their* **points all turn backwards** *towards the throat.* There are **no teeth for tearing and cutting through flesh,** such as the flesh-eaters have; there are **no chewing** or **grinding teeth.**

Where have we seen teeth like these?

2. *The children will, of course, remember the* **teeth of the fish.** *Lead them to tell that most fishes feed on one another, and on all sorts of animals that live in the water; that they do not eat their prey as other flesh-eaters do;* **they swallow them whole.**

Snakes too feed on other animals, and like fishes **they swallow their prey whole.**

*Elicit that those* **sharp, spiky, backward-pointing teeth** *are* **just suited for holding the victim** *between the jaws, while it is* **gradually being swallowed.**

3. *Before proceeding further, pause to notice the* **long forked tongue.**

In the living animal **the tongue is restless**—ever on the move.

*Explain that it is* **the snake's feeler**; *it is* **perfectly harmless,** *although ignorant people still think it is poisonous.*

1. THE HEAD.—*Point out in the next place that, in the animals around us, only one part of the head,* **the lower jaw, is capable of movement,** *and even this movement is somewhat limited.*

*Tell that the snake is able to move, not only the* **lower jaw,** *but the* **upper jaw** *as well. The mouth can be* **widely opened.** *The* **bones of both jaws,** *too, instead of being firmly fixed to the other bones of the head, are jointed by* **ball-and-socket joints,** *and held together by* **elastic muscular bands.**

2. Imagine a snake now in the act of **swallowing its victim.** It takes a firm hold with its teeth, and as **these point backward,** there is no chance of their letting go, while the act of swallowing takes place. All this time the **jawbones have been widening,** and **moving out of their sockets,** until space is made for the creature to swallow an animal as big round as itself. And so the victim passes down, and is **swallowed whole.**

THE BODY.—*Now lead the children to think of the ball-and-socket joints, by which the ribs are jointed to the backbone.*

*Refer to the* **freedom of movement,** *which this arrangement gives to the ribs.*

*Tell that as the body of the victim passes downwards after being swallowed,* **it simply pushes aside the ribs** *to make room.*

The overlapping outer **scales readily slip aside too,** as the body of the snake expands with its meal.

### IV. Food and Haunts

*Picture the snake, with* **no means of defence, without even teeth to bite.** *Yet it feeds on other animals, which it must catch and swallow. Evidently those animals must be weaker, and more defenceless than itself.*

*Excite the children's curiosity on this point, and then tell that this snake* **feeds on frogs and newts.** Hence it always **makes its home near the banks of ponds and ditches,** and in **marshy places.**

### Summary of the Lesson

1. The common grass snake is perfectly harmless.
2. All the bones of its skeleton are jointed together with ball-and-socket joints.
3. Its body is covered with scales. The scales on the under part of the body are jointed to the ends of the ribs.
4. These scales on the belly of the snake are like an immense number of feet.
5. The snake's spiky teeth point backwards. It cannot chew; it swallows its prey whole.
6. It feeds upon frogs and newts. It lives near ponds, ditches, and marshy places.

## Lesson XXXIV

## THE VIPER (COMPARED WITH) THE COMMON SNAKE

Brown's pictures of the "Common Snake" and the "Viper" will be required.

### I. Like the Common Snake

1. *Commence by leading the children to tell all they can about the nature of the common grass-snake of the last lesson, and then*

*introduce the picture of the viper—another of our English snakes*—**a poisonous one.** *Tell that it is* **the only poisonous snake found in this country.**

*Note that in its* **shape** *and general appearance* **it resembles the common snake.** *But explain that it is* **much smaller**; *it rarely measures more than* **20 inches** *in length.* It is sometimes known as the **adder.**

2. It has the same **long, slender, rounded body,** covered with **overlapping scales.** It moves about with the **same gliding motion,** by means of its **ribs** and the **large scales on the under side** of its body. Like the common snake too it **feeds on other animals,** which it **swallows whole.** It has the **same long, forked, restless tongue.**

*Explain that the tongue is quite as* **harmless as the tongue of the common snake,** *in spite of what ignorant people say.* It is **a feeler** and **nothing more.**

## II. UNLIKE THE COMMON SNAKE

THE HEAD.—*Compare the heads of the two* :—

The head of the common snake is long and slender.

The viper's head is **pointed in front,** and broadens out behind the eyes into something of **a triangular shape.** But the great feature of the viper's broad flat head is the **V-shaped mark between the eyes.**

*Point this out in the picture, and show that it is formed by* **two black stripes,** *which* **meet there at an angle.**

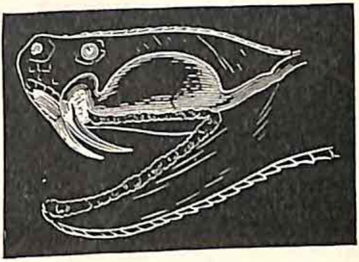
*Note also that it has* **a cruel, deadly look in its eyes,** *which we did not see in the eyes of the harmless common snake.*

THE BODY.—*Call attention to the body next. Notice that the neck is somewhat* **smaller** *than the* **back** *of the* **head,** *and that the* **scales** *on the body are marked with dark* **zigzag patches.**

These black patches show up very distinctly against the general colour of the body, which is **mostly olive,** sometimes **brown,** and sometimes **brick-red.**

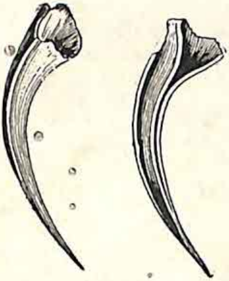
1. THE FANGS.—*Turn to the picture again, and point out the* **two long, curved, sharp-pointed teeth** in front of the upper jaw. These we call **the fangs.**

We **cannot see them** when the **mouth is shut,** for they are then **drawn up,** and lodged in the gum.



They are sometimes called poison-fangs; but this is not quite correct, for there is **no poison** in the **fangs** themselves.

2. *Explain that the* poison comes from **two bags,** lodged in the back part of the mouth. The fangs themselves are really **hollow tubes,** and when the snake is about to dart at its victim, not only do the fangs show themselves, but the **hollow tubes** within them carry a quantity of **poison,** which the poison-bags pour into them for the occasion.



*Show these* **poison-bags** *and* **fangs** *in the picture, or by means of a black-board sketch.*

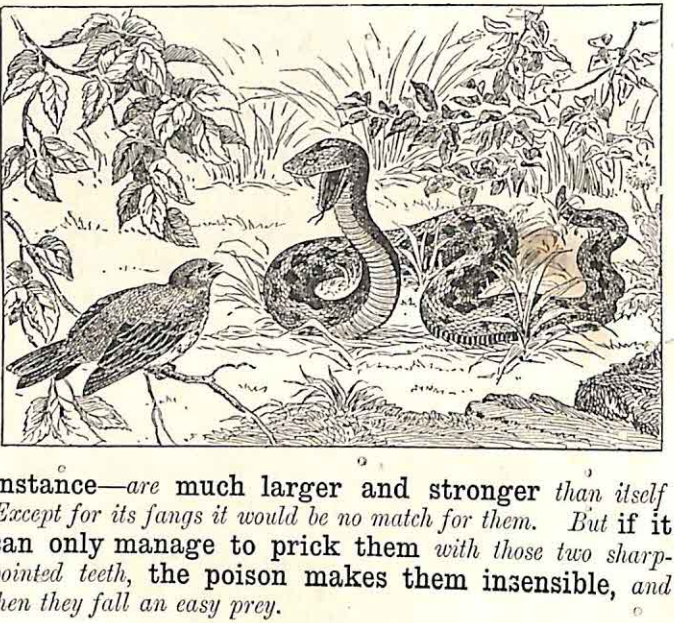
3. The adder, or viper, preys upon **rats, mice,** and **birds.** To them its **bite is fatal.** It is **dangerous,** though **not often fatal to people,** except to delicate, unhealthy persons. The viper is **extremely voracious,** and will often devour more than it is able to digest.

*Describe its mode of attacking its victim.* It creeps up with a **stealthy, gliding, noiseless movement,** until within striking distance, then gives a **lightning-like dart forward.**

One bite is quite sufficient, for the sharp tooth not only **makes a wound,** but at the same time **leaves a quantity**

**of poison in the wound,** which soon **kills the victim,** or **renders it insensible,** so that the snake can gorge it at its leisure.

4. Why should this snake have fangs and poison-bags? *Remind the children that it is a* **very small creature,** *and point out that some of the animals it preys on*—**rats, for instance**—*are* **much larger and stronger** *than itself Except for its fangs it would be no match for them. But* **if it can only manage to prick them** *with those two sharp-pointed teeth,* **the poison makes them insensible,** *and then they fall an easy prey.*



## III. Haunts and Habits

*Point out that, as the viper does not feed on frogs, newts, and animals of that kind,* **we should not expect to find it living,** *with the common snakes, in* **wet marshy places,** *or by the side of* **ponds** *and* **ditches.**

It is mostly to be met with **in the thickets and low brushwood** of our forests and woodlands; it likes to **lie basking in the sun** on the **dry open heaths** and **sandy**

**banks:** Its hole or nest is sure to be found close to some such spots as these.

## IV. OUTDOOR OBSERVATION

*The common grass-snake is found in almost every part of the country, and it would therefore be well, wherever possible, to follow up the teaching of the last two lessons by actual outdoor observation.*

*To do this effectively it would be almost necessary to enlist, at the proper times, the services of outside helpers, such as the keeper, some of the farm-hands, stablemen, and others.*

1. THE SNAKE LAYS EGGS.—*The common snake frequently chooses* **a dung-hill,** *or* **a decaying compost-heap** *on the farm, as a place in which* **to lay its eggs.** *If the men are successful in lighting upon a nest of eggs, by all means take the class to see them.*

*There may possibly be* **a score of eggs** *in the nest, but they will all be found* **glued together by some sort of sticky substance,** *with which the mother covers them.*

*They are* **small white eggs,** *but instead of a hard egg-shell, they have only a sort of* **thin paper-like covering.**

2. Why should the mother snake lay her eggs in such a place as this?

How can she hatch them if she leaves them in this way?

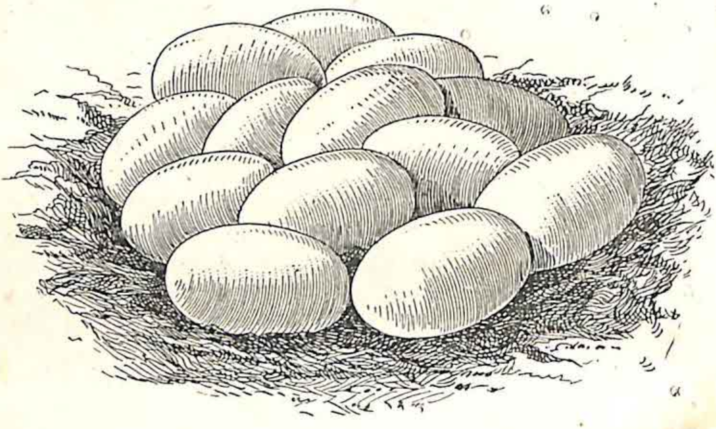
*After rousing the curiosity of the children on this point, explain that the mother snake takes no further care of her eggs, after she has laid them.* **She could not hatch them** *herself, with warmth from her own body,* **because snakes are cold-blooded animals.**

*She does the best she can for them by placing them on this dung-hill, and then she leaves them.* **The warmth of the rotting manure** *is sufficient to hatch them.*

3. *With regard to the snake itself, there should be no difficulty*

*in stumbling across one during a ramble with the class, provided of course it is sought for in its natural haunts—in damp meadows and marshy places, and by the sides of ponds and ditches.*

*Remind the children that such localities are* **most unlikely**



**places to meet with the poisonous viper,** *for this snake chooses* **dry sunny spots for its haunts.** *But besides that, the viper is becoming very scarce everywhere: it is very rarely met with now. Hence there need be no fear on that score.*

4. *It may, however, be an easier matter to find your snake than to bag it, especially if it be near its hole, for it is* **very sharp and nimble** *in its movements. If it is surprised at some distance from its hole, it will either* **wriggle off at its smartest speed,** *making a peculiar unmistakeable* **rustling among the undergrowth** *as it goes, or it will lie close, and in its terror* **send out through the pores of its skin** *a sort of* **thick sweat,** *with a* **most disagreeable smell.**

5. *This is its means of defence. Compare it with* **the polecat,** *the* **toad,** *and other animals. The abominable stench from the skin will remain on the hands for a long time after handling it; in fact, it will take many washings to remove it.*

*Remind the children that there was* **no bad smell from the tame snake,** *which we had for the lesson in school. Explain that* **in its tame state the creature loses its fear,** *and it does not send out this evil-smelling sweat from its body.*

1. WINTER SLEEPERS.—*The services of the keeper would be most invaluable in a winter-hunt for a nest of these snakes, as he would be likely to know their haunts better than any one else*

*They frequently choose* **a deep hole in a bank,** *or* **under the gnarled roots of an old tree,** *and here* **numbers of them collect together,** *and lie* **coiled up asleep** *all through the winter.*

2. *Elicit that, as winter approaches,* **the frogs all take themselves off to the bottom of the ponds,** *and settle down in the mud there for their own winter sleep.*

Hence the snake is a winter sleeper, **because there is no food for it to eat,** till the frogs come up again on the return of spring.

## SUMMARY OF THE LESSON

1. The viper or adder is smaller than the common snake.
2. It has a black V-shaped mark between the eyes.
3. Its body is marked with dark zigzag patches.
4. It has a pair of long, curved, pointed teeth, or fangs, in front of the upper jaw.
5. The fangs are hollow tubes; they carry poison from the poison-bags to leave in the wound, when they bite their victim.
6. The viper chooses dry open heaths and sandy banks for its haunts.
7. Snakes produce their young from eggs. The eggs are not hatched by the mother snake.
8. Snakes are winter sleepers.

## Lesson XXXV

## THE BLIND-WORM (COMPARED WITH) THE COMMON SNAKE

The Teacher should be provided with a living specimen, wherever it is possible to get one, and a picture of the animal.

### I. GENERAL APPEARANCE

*PRODUCE the living specimen, and lead the class to tell all they can of its general appearance.*

*They will probably say it is a little snake. Let this pass for the present, merely noticing that it has the* **same long, rounded, tapering body, without any appearance of limbs**; a **similarly shaped head**; and the **same peculiar covering of over-lapping scales,** *as they are now familiar with in the snake.*

*Measure it with a rule.* It measures **about a foot in length,** so that the common snake is two or three times as long. Still to all outward appearance it is a small snake.

*Notice also that it moves about with the same* **gliding, creeping kind of movement,** *as the snake; and that it can* **bend and twist its body in any direction.**

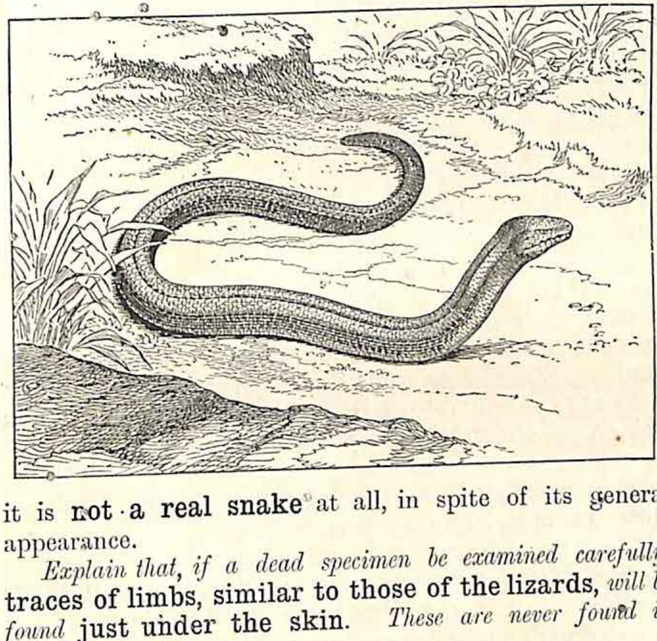
*Lead the children to describe the* **backbone of the snake,** with the peculiar **ball-and-socket** arrangement for jointing the separate bones together.

*Elicit the purpose of this.* These peculiar joints give the long body its supple **flexibility,** enabling it to **twist and bend** with the greatest ease.

*Lead them next to describe* **the ribs**; the manner in which they are **jointed to the separate vertebrae** of the back-bone; their **free ends** and **scale feet** for the purpose of locomotion, *and so on.*

*Explain that this little animal,* **the blind-worm,** *is built on exactly the same plan as the snake in all these respects.* It has a **back-bone, ribs,** and **scale feet,** like those of the snake, and it **uses them in the same way,** when moving about from place to place.

The blind-worm, like the snake, is a **reptile** ; and yet it is **not a real snake** at all, in spite of its general appearance.



*Explain that, if a dead specimen be examined carefully,* **traces of limbs, similar to those of the lizards,** *will be found* **just under the skin.** *These are never found in any of the snakes.*

The blind-worm is a **curious kind of lizard**—a **lizard without legs**—a **snake-like lizard.**

### II. Curiously Named

*Pass on next to consider its name*—**blind-worm.**

1. Not a Worm.—*Take exception first of all to the name* **worm,** *and call upon the class to explain why this must be a*

*bad name. Elicit that* **worms** of all kinds are **boneless animals.**

This creature **cannot be a worm,** for it has an **internal bony skeleton,** with a **backbone** running through the body from head to tail.

2. NOT BLIND.—*Proceed next to call attention to the pair of* **small, but very bright eyes. They shine like beads.**

*Explain that* so far from being blind, this little creature has **very sharp sight.**

*Notice the* **defenceless** *form of the animal. It is* **utterly unable to fight** *for its life. Lead the children to tell that,* **Nature never leaves her creatures without some means of protection against their enemies.**

Those that cannot fight, are endowed either with the power of **rapid movement,** or with **keen sight and hearing,** to warn them of approaching danger. **Good sight is necessary to a defenceless creature of this kind.**

The name—blind-worm—is a bad one in every respect. This creature is **neither a worm, nor blind.**

3. NOT SLOW.—*Notice next that it has another name—* **slow-worm**—*which is quite as objectionable as the first.*

*Watch the creature move about on the floor. Let some one try to catch it.* Its movements are **anything**[1] **but slow.** It glides about **so rapidly** that it is a difficult matter to lay hold of it, and when you grasp it at last, it will most likely **slip through your fingers,** and get away.

It is neither a **slow** worm, nor a **blind** worm, in spite of its names.

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[1] In the ordinary way it is not quick in its movements. It does not require rapidity of movement to capture its chief prey—the slug. But in presence of danger, no doubt fear lends speed, and it can move rapidly enough then.

### III. HABITS AND FOOD.

1. POPULAR ERROR.—The blind-worm is one of those unfortunate creatures, which are often ill-treated through ignorance and prejudice.

*Point out that, from its* **size and general appearance,** *it might easily be* **mistaken, in the shock of a first glance,** *for a* **viper.**

This has frequently occurred, and the poor blind-worm, a **perfectly harmless creature,** has been struck down, and beaten to death, **in mistake for that poisonous snake.**

2. *Tell, too, that there is still a common belief among country people not only that the blind-worm is* **poisonous**; *but that it* **bites cattle**; *and that* **its bite is very dangerous,** *if not fatal to them.*

*Explain that all this is* **absolutely wrong.** *Show, either in the living animal, or with the help of the picture, that its* **mouth is so small,** *and its* **teeth so tiny,** *that there need be no fear at all as to its bite, either for ourselves or the cattle.*

3. The little thing is **perfectly gentle and harmless**; it has **neither the power nor the will to bite.** But even if it did bite, those **tiny teeth could not do the slightest harm,** for they cannot **even draw blood**; and they are **perfectly innocent of poison.**

*Notice that like many other reptiles, the blind-worm has a* **forked tongue,** *which it is in the habit of* **constantly thrusting out of its mouth.** The tongue is a **feeler,** and **nothing more**; *but ignorant people imagine it to be a poison sting, and the gentle, harmless blind-worm, like the common snake, is looked upon by them as a poisonous animal.*

1. SNAPPING ITS TAIL.—*Tell next of its strange habit of* **snapping off its tail,** *when it is alarmed by a sudden attack.*

More than half the entire length of the creature consists of the tail, and by a peculiar formation of the joint, it is able to **snap it off,** as easily as one could **snap a stick of sealing wax.** It then looks as though the creature had broken itself **in two halves.**

The strangest part of it is that after a time **a new tail grows,** to take the place of the lost one.

2. *Explain that this is a peculiarity* **common to several of the lizard family,** *but is not met with in the snakes.* That is another reason for classing this snake-like animal **with the lizards,** rather than with the true snakes.

Many explanations have been given of this peculiar habit,—the most probable one being that it is done as a means of escape. The tail, after it is severed, leaps and twists about so violently for some time, that it is sure to attract attention, and while the attacking enemy is **watching the writhing tail,** the creature itself quietly **steals away out of danger.**

1. FOOD.—*Return to the teeth once more, as an indication of the food and habits of feeding.* What kind of food would suit an animal with those **tiny, spiky teeth?**

*Explain that it lives chiefly on* **slugs,** *but that it also eats* **insects** *and* **worms,** *and lead the class to point out from this the absurdity of calling it a blind-worm. All insect-eaters require good sight. Lead them also to infer that, like all such feeders,* **it must be a winter sleeper.**

2. As autumn approaches, it retires **beneath the heaps of fallen leaves heath, and brushwood,** and **buries itself in the ground.** It **wakes** from its winter sleep **earlier than most other reptiles,** for it is up and about with the **first return of Spring.**

Its favourite haunts are **woods, hedgerows, heaths,** and **commons,** where it can find **shelter from its enemies,** and **abundance of food.** Like many other reptiles, it loves to lie **basking in the sun.**

3. In June or July the female gives birth to a **numerous family**, usually from seven to twelve in number, and the **little ones**, almost from the first, are **active and lively** enough to seek their own food.

*Point out that, in this respect again, the blind-worm resembles the lizards rather than the snakes.*

### SUMMARY OF THE LESSON

1. The blind-worm or slow-worm is not a snake. It is a lizard without legs.

2. It is not a worm; it is not blind; it is not slow.

3. It is perfectly harmless and gentle in its nature. Its mouth and teeth are not made for biting; its forked tongue is simply a feeler; it is not poisonous.

4. When alarmed, it sometimes snaps off its long tail to assist its escape.

5. It feeds on insects, slugs, and worms. It requires good sight to catch its prey.

6. Its home is in the woods, hedgerows, heaths, and commons. It is a winter sleeper.

7. Its young ones are born alive.

# OUR BRITISH TREES

## Lesson XXXVI

## BUDS AND BLOSSOMS

### A SPRING RAMBLE (TIME—EARLY IN APRIL)

### I. INTRODUCTION

1. *BEFORE setting out explain the purpose of the ramble*:—

There is much to be learned about the trees, but if we would know them thoroughly, we must visit them and observe them at different seasons of the year. All through the winter they have been bare and leafless, but now the budding time of spring has come, and they are putting forth buds and blossoms. We will visit them, and observe them to-day in their spring dress.

2. *Explain that, just as each animal in its natural state has its own special locality, and is rarely found far from it, so it is with trees to some extent.*

One tree likes a moist situation, another prefers a dry soil; one rejoices in the breezy hill-side, another in the low-lying meadows. But each tree flourishes best in its own natural locality.

3. *Explain that, year by year, as autumn comes round, thousands of seeds are shed by the trees, to be scattered far and wide by the wind; but those only come to perfection, which fall on suitable spots of ground.*

*Man of course acts upon this hint in planting trees, and hence it is usual to group them into different classes*—**Hedgerow Trees, Forest Trees, and River-side Trees.**

## II. Hedgerow Trees

1. *Take, as types of these, the* **elm** *and the* **ash**—*both of them tall stately trees.*

*In early spring, before the leaves appear, the ash is easily recognised by the singular* **blackness of its buds.** *But by this time (April) both trees are most likely* **bursting their bud-cases**—*indeed the swelling buds* **will soon break into leaf.**

*Shake the trees, and call attention to the falling showers of these loosened bud-cases.*

2. *The elm, like the ash, is readily distinguished at this time of the year, but not by its buds.*

Towards the **end of March,** some weeks before the leaves come, this tree begins to be **gay with clusters of pink flowers.** *Some of these flowers are probably still to be seen; call attention to them now.*

3. *The ash puts forth its blossoms* **with the leaves,** *but the flowers are neither large nor showy: they are hidden too by the swelling leaf-buds, so that they are not easily seen from a distance.*

*Endeavour, if possible, to get specimens of both flowers for examination and comparison.*

4. *Examine the* **flowers of the elm** *first.*

They are **pink, bell-shaped, perfect flowers,** with stamens and pistil all complete. They grow in **close clusters.**

*Compare them with the* **flowers of the ash.**

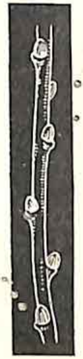
These grow **in loose straggling spikes** from the sides of the branches; the flowers themselves are **small** and **insignificant**; they have very little of the usual appearance of flowers, for they have **neither sepals nor petals,** and therefore **no bright colours of any sort.**

## III. FOREST TREES

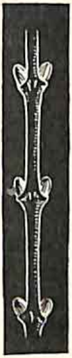
*Take the children into the wood next, and explain that we are now going to visit some of the trees, which properly speaking belong to our forests and woodlands, although they are sometimes found in other situations.*

*Select, as types of these, the* **oak, beech,** *and* **birch**—*all of them* **now in bloom,** *and all* **bursting into leaf.**

*Cut a budding twig and specimens of the flowers from each.*



OAK.



BEECH.

BUDS.—*It will be sufficient for the present to note* **the arrangement of the buds** *on all three. The leaves themselves will be dealt with later on. Notice that:—*

(*a*) In the oak the buds **follow each other singly in a sort of spiral round the twig.**

*Point this out, and show that, starting from any given bud, we come, after one or more turns of the spiral, to another, exactly in a line with the first.*

This is called **alternate budding.** *Notice that in the elm the arrangement is the same.*

(*b*) Compare this with the different arrangement in the beech and birch. The buds in both these trees **spring in pairs from opposite sides of the twig.** This we call **opposite budding.**

1. FLOWERS.—*Show the flowers of all three, and compare them one with the other, and with those of the elm and the ash. Lead the children to discover that :—*

(*a*) Each tree bears **two different kinds of flowers.**

(*b*) The flowers of one set **hang in a drooping tassel** or **catkin**; the others are **lower down** on the stem, and have **shorter stalks.**

(*c*) Those which form the drooping catkin **contain stamens only.** They are **barren** or **male flowers.** *They are not ripe enough yet, but later on get some of them collected ; and then, if they are shaken,* **showers of pollen will fall from them.**

(*d*) Those which spring from the stem lower down **contain a pistil, but no stamens.** These are the **female flowers,** and they produce fruit and seeds.

2. *Notice that all three trees bear these* **male and female flowers,** *although the flowers of one tree are not like those of the others.*

**The catkins of the oak** are **small, almost insignificant,** and they **hang in clusters.**

In the beech **the male catkins,** with their **conspicuous yellow anthers,** are readily distinguished from the female flowers, and so are those of the birch.

Nothing can be more beautiful than the **graceful hanging tassels of the birch,** when it is in full bloom.

## IV. RIVER-SIDE TREES

1. THE WILLOWS.—*Lead the way to the river-side now, and call attention to the trees, which fringe the water's edge, and*

*overhang the stream. Tell that these are* **the willows.** *Notice how different they are in general appearance from any of the trees we have visited.*

These trees delight in a moist—**even wet**—situation. They are almost always found in **low marshy places,** and **by the banks of streams and rivers.**

2. *The children will again observe that, although these trees are* **only just budding into leaf,** *they are* **all in full blossom. The flowers come before the leaves.** They hang in **tassels,** or **catkins.**

*Collect some of the catkins for examination, and comparison with those of the oak, beech, and birch.*

3. *Notice, in the first place, that the flowers in these catkins are* **either male or female.** Some of them have stamens but no pistil; some have a pistil, but no stamens. But **none of them have stamens and pistil as well.**

*Distinguish the male from the female catkins* **by dusting out the pollen** *from the already ripened anthers of the former.*

4. *Notice, in the next place, that these male and female flowers* **are never found on the same tree,** *as are those of the oak, beech, and birch.*

**The male flowers grow on one tree, the female flowers on another.**

*Call attention to* **the sweet scent of these flowers.** *Lead the class to tell that* this is for the purpose of **enticing the insects** to them.

*The children have, of course, already recognised these catkins of the willow as the* "**pussy-cats,**" *which they gather under the name of* "**palms**" *on Palm Sunday. In some parts of the country* **these trees are popularly known as palms** *because of this.*

5. *The catkins are* **a bright golden yellow** *colour now, but when they first make their appearance* **they are silky tassels,** *with a* **pure silvery lustre.**

*If any of the leaves are sufficiently advanced to show it, the distinction between* **the white willow, the round-leaved sallow,** and **the osier** *might be pointed out. Too much, however, need not be made of this now, as the leaves will be dealt with later on.*

1. THE POPLARS.—*Visit the poplars next, explaining that these trees* **belong to the same family as the willows.** *Like the willows,* **they are in full bloom,** *although as yet the leaf-buds are but just beginning to burst.*

*Call attention to the* **deep red catkins,** *which hang in profusion on one of these trees*—**the black poplar.**

*They are probably by this time beginning to fall, and strew the ground at the foot of the tree.*

*Notice that as they lie there,* **they look like large red caterpillars** *in various writhing attitudes.*

*Pick up some of them, and examine them to show that the* **bright rich colouring** is due to the **red anthers of the flowers.**

Hence these catkins are **the male flowers.** The male and female flowers, like those of the willow, **never grow on the same tree.**

2. *N.B.—The white poplar, and the* **aspen,** *or* **trembling poplar,** *are probably budding into leaf now; but the leaves of the black poplar do not show till the middle of May.*

*The flowers, rather than the leaves, were the main object of this spring visit. The leaves will be dealt with in a later lesson. For the present we have simply glanced in passing at the few that are open.*

*Needless to say, good specimens of all these flowers should be collected now, for preservation in the school museum. They will require to be pressed between sheets of blotting paper in the usual way, and labelled for future reference.*

## SUMMARY OF THE LESSON

1. Most of the trees blossom before the leaves burst.
2. The ash puts forth its blossoms with the leaves.

3. The elm bears clusters of pink, bell-shaped, perfect flowers.

4. The oak, beech, birch, poplar, and willow bear male and female flowers.

5. In the oak, beech, and birch, male and female flowers grow on the same tree.

6. The male flowers hang in tassels or catkins.

7. Willows and poplars bear male or female flowers, but never both.

## Lesson XXXVII

## THE TREES IN SUMMER

### TIME—MIDDLE OF JUNE

### I. INTRODUCTION

*SELECT a typical summer day for the ramble, and explain on the way the object of visiting the trees at this season of the year. Remind the children that* **in the spring-time** *we found them* **budding and blossoming**—*the leaves had not yet come.*

They are now clothed in their summer verdure, and to-day we will examine and compare the leaves, and the trees themselves.

### II. HEDGEROW TREES

1. THE ELM.—*Visit this tree first, and proceed to notice point by point*—its towering height (70, 80, and sometimes 100 feet); **its rough rugged stem,** and **immense spreading arms**; and the **dark green colour of its foliage.** *When the leaves first appear* **in the spring,** *they are of* **a much brighter green,** *but they get darker as the summer advances.*

2. The elm is one of the grandest of our timber trees. It is specially suited for planting in **hedgerows** and **avenues.**

*Notice the* **suckers,** *which the tree sends up from its roots all round.*

*Tell that* the elm is usually **raised by means of these suckers**—very rarely from seeds.

3. *Cut a twig from the tree now, and examine the leaves carefully to show that :—*

(*a*) The blade is all in one piece—**the leaf is a simple leaf.**

(*b*) The leaf is small compared with the size of the tree—it is between 2 and 3 inches long. *The small leaves give a natural lightness to the tree, in spite of its immense size.*

(*c*) The leaf is **oval in shape,** with **doubly saw-like edges,** *i.e.* there are small saws upon the larger ones.

1. THE ASH.—*Call attention to this tall elegant tree next. Cut a twig, and at once proceed to examine the leaves, leading the children to discover for themselves that :—*

(*a*) This leaf is **not all in one piece**—one blade. It consists of **several pairs of leaflets,** arranged on either side of the midrib, **something like the barbs of a feather.**

(*b*) The leaflets have **saw-like edges.**

(*c*) The leaf of this tree (the common ash) has **five**[1] **pairs of leaflets,** with a single one at the extremity of the midrib.

2. *Elicit that a leaf, which consists of several leaflets, is called a* **compound leaf.**

*Tell that the ash-leaf is known as a* **feather-shaped leaf,** *because it is made up of* **pairs of leaflets.**

*Watch the graceful waving of these feather-shaped leaves in the wind.*

Elegance and beauty rather than rugged grandeur distinguish this tree.

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[1] Some members of the family have more than five pairs, some have less. The mountain ash, for example, has seven pairs of leaflets, and a single one at the end.

3. *Tell, however, that handsome as the ash is in the hedgerows, it should never be planted for ornament in places which are meant to be kept neat, for* **the leaves with their long stalks fall early in the autumn,** *and by their litter destroy the beauty of such places.*

*Neither should this tree be planted on tillage land, as* **the dripping from the leaves injures the corn,** *and* **the roots tend to draw away all nourishment from the soil.** *Nor should it be planted near pastures, for* **if the cows eat the leaves or shoots,** *the butter will become rank and of little value.*

### III. FOREST TREES

1. *Select as before the* oak, beech, and birch, *as types of these trees, and take the children into the wood to examine them, and compare them one with another.*

*Note the peculiar growth of the* monarch of the forest—*its* **rough, gnarled bark,** *its* **immense arms,** *which* **stretch out horizontally** *and cover a large expanse of ground.*

*Compare it with the beech, its rival in size.* The branches of this tree mount upwards, instead of spreading out horizontally. Hence the beech does not cover so much ground as the oak.

2. *Notice that* **the bark** *of the beech has* **a smooth surface.** *Tell that as the tree advances in age, all sorts of* **knobs and hollows form on the trunk,** *the bark assumes an* **olive-grey colour,** *and this is* **patched** *here and there with* **various tinted lichens,** *and* **dark-green velvety moss,** *making the tree an object of picturesque beauty. Endeavour to find a tree answering to this description.*

3. The birch may be easily distinguished from other trees at a glance, by the peculiar **silvery whiteness of its bark,** and by its **slender graceful form.**

*Cut twigs now from each of these trees, and proceed to examine and compare the leaves:—*

4. *Place the leaves side by side for inspection and comparison; and deduce as the result of the inspection that:—*

(*a*) Each leaf is all in one piece. The blade is not made up of several leaflets. **All three are simple leaves.**

(*b*) **None of the three have smooth edges;** yet each one is different from the others.

(*c*) **The oak-leaf is deeply notched,** and this gives it a very peculiar shape.

(*d*) **The leaf of the beech** is **oval in shape,** and has **slight indentations** round its edges.

(*e*) **The birch-leaf is triangular rather than oval in shape;** it tapers to a point, and has **a doubly saw-like edge,** one set of teeth being larger than the others.

## IV. River-side Trees

1. The Willows.—*Lead the way to the river-side now, and call attention to* **the willows.**

*Remind the class that, when we saw these trees in the spring, they were bare of leaves, but their catkins of flowers were in full bloom.*

Like the rest of the trees, they are green and leafy now. We have come to examine their leaves, just as we examined the flowers in the spring.

*Cut twigs from suitable trees, and proceed to examine the leaves as before:—*

2. *Choose first the leaf of the* **common white willow.**

*Note that it is* **long, narrow, and pointed,** *and has* **fine, saw-like edges;** *and that the* **under surface of the leaf is white.**

*Tell that this is the leaf of the finest of the willow family—* **the white willow.**

We sometimes find it with **a pollard top,** sometimes as **a large timber tree.**

3. *Show next the leaf of the* **round-leaved sallow,** *another member of the family.*

*Notice that* **this leaf,** *instead of being long and narrow,* **is broad—almost round.**

The leaf is **dark-green above,** but **the under side is clothed with a white down,** like cotton-wool.

*Explain that this was the willow, from which we plucked the* **"palms"** *in the spring.* It is sometimes known as the **goat willow,** and is a much smaller tree than the common white willow.

4. *Produce now the leaf of the common* **osier,** *if there be any available. Point out that* **this leaf is long, narrow, and pointed** *like the leaf of the common willow; but* **its edges are smooth.**

*Tell, or elicit, the uses to which these osiers are put.*

1. THE POPLARS.—*Collect lastly leaves of the white and black poplars, and the aspen.*

*Take the* **white poplar** *first. Notice the peculiar effect which every breath of wind causes in the tree itself, and then proceed to examine the leaves which were gathered.*

*Show that* **the leaves are dark-green above,** *and that the* **under surface is covered with a snowy-white downy substance.**

It is a peculiar characteristic of all the poplars that, the slightest breath of wind **keeps the foliage in a constant quiver.** As the leaves move, they show first the green and then the white side.

2. *Note the same thing, but in a more marked degree, in* **the aspen,** *which is also known as* **the trembling poplar.** *Remind the children that the phrase "trembling like an aspen leaf" has passed into a proverbial saying.*

*Explain, and show with the help of the specimen, that this leaf has an exceptionally* **long slender leaf-stalk.** *Hence the greater freedom of movement—the greater trembling.*

*Note that this leaf is* **dark glossy green on the upper surface,** *and* **paler in colour beneath,** *but it has no white downy covering, similar to that on the under surface of the white poplar.*

### SUMMARY OF THE LESSON

1. The leaf of the elm is simple, oval, and doubly saw-like.

2. The leaf of the ash is compound. We call it a feather-shaped leaf. The leaflets have saw-like edges.

3. The leaves of the oak, beech, and birch are all simple. The birch has a doubly saw-like edge; the beech has slight indentations; the oak is deeply notched.

4. The white willow has a long, narrow, pointed leaf with saw-like edges.

5. The round-leaved sallow, or goat willow, has a broad round leaf.

6. Both are white on the under side.

## Lesson XXXVIII

## THE TREES IN AUTUMN

### TIME—OCTOBER

*THE purpose of this autumn ramble among the trees is two-fold:—*

*(1) To observe the glorious effects of the changing tints of the fading leaves.*

*(2) To gather, examine, and compare the seeds of the various trees, which ripen at this season of the year.*

### I. AUTUMN TINTS

1. *Note first the general effect of the* **blending of the various colours,** *wherever the trees are massed together in clumps, and then proceed to select certain trees for closer observation.*

*Gather leaves in various stages of decay from the* **ash, beech, birch, elm, and poplar.** *Note that all these leaves are* **yellow.**

*Compare them with others still on the trees, from which they were taken, and observe that the green leaves in each case* **gradually assume a paler and paler tint,** *before they become positively yellow.*

2. *Now compare these leaves one with another, and let the children discover that each has its own peculiar tint.*

The yellow of the **elm-leaf,** for example, is **a deep full ochre colour**; the **ash-leaf**[1] is **a bright pleasing yellow**; and **the leaf of the beech** is **an intense orange-yellow.** This tree on a bright day seems to be bathed in golden sunshine.

3. *Gather next, for comparison with these,* **the leaves of the oak and hornbeam.**

*Note that these leaves are* **a deep brown colour**—*not yellow.*

*Observe that the trees themselves have* **green** *and* **brown leaves** *side by side, with scarcely any intermediate shade.* **The green leaves seem to change at once to brown** as they fade.

4. *Compare these again with the* **leaf of the sycamore.**

*Notice that the leaves on this tree are of* **many shades of colour.** Those which have not yet begun to fade are **green**; those in the first stage of decay are **yellow**; others have changed the yellow for **a golden brown**; and others again have passed from brown to **a bright red.**

5. *It would be impossible to avoid noticing, in the midst of all these changes, those trees and shrubs which are* **green still**—*are undergoing no change—such as* **the firs and pines,** *the* **holly, ivy, box, laurel,** *and others.*

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[1] This leaf is much tenderer than most others. In a cold autumn it shrinks from the nipping winds and early frosts, and either falls very quickly, or decays in a dark muddy unpleasing tint. But in a mild season the ash often retains its green colour, when even the oak and the elm have assumed their autumn appearance.

*Elicit that all these bear their green leaves throughout the year; hence they are called* **evergreens.**

6. *Tell that those which* **shed their leaves every autumn** *are known as* **deciduous trees,** *and explain that the word* **deciduous** *(falling down) refers to the falling leaves.*

*It will be sufficient for the present to note that these masses of green, in the midst of so many and varied tints, lend an additional charm to the view at this season of the year. Promise to deal with the evergreens themselves later on.*

## II. SEED-TIME

NUTS.—*There will be no difficulty in finding* **acorns, beech** *and* **hazel nuts,** *for they are abundant everywhere in October.*

*Needless to say, they should be* **plucked from the trees themselves,** *and by the children.*

*The hazel is more commonly met with as a hedgerow bush or shrub than as a tree, and it has already been dealt with in Book II., Lesson XXXVI.*

*Of course, in referring to it now, the children should be required to describe it.*

1. **The Acorn.**—*In making a collection of these (to figure of course in the school museum later on) the teacher should endeavour to find specimens of both kinds.*

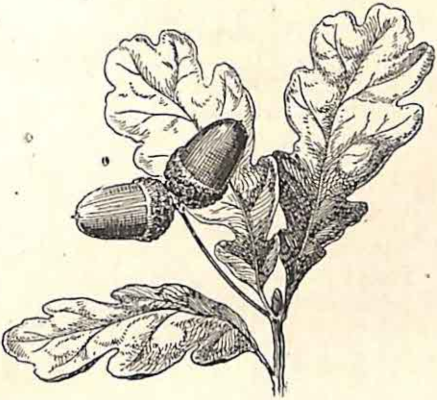
One tree bears its acorns **supported on long footstalks**; another, differing from the former in nothing else, has its acorns **seated directly on the branch.**

*It will be interesting to show both of these.*

2. *Let the children examine the acorn itself now. Separate* **the little rough-looking cup** *from the nut which it contains.*

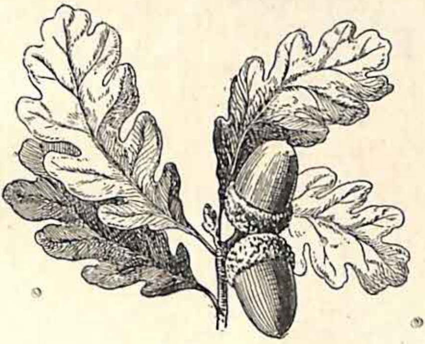
*Open the nut itself carefully, and point out that it is really* **a large seed, with two seed-leaves** *and* **the germ between them.**

*The teacher, of course, would lead the class to associate these*



**double seed-leaves** *of the acorn with* **the net-veined leaves** *of the tree itself, and with the general character of the tree.*

3. *The boys are already familiar with the value of the acorn, as* **food for pigs** *at this time of the year. Tell that, in the*

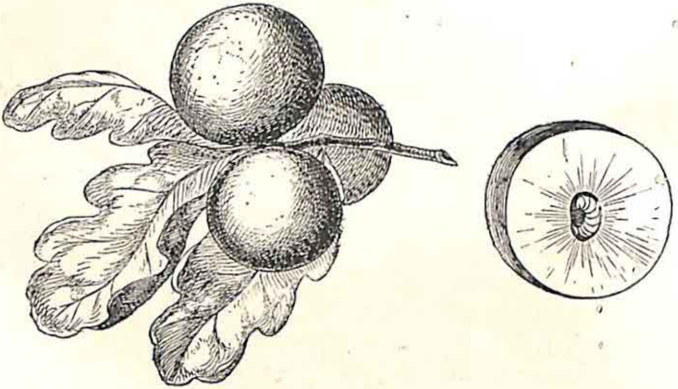


*remote ages, long, long ago,* **the rude savage inhabitants of these islands** *had little else, but acorns, and such things, to look to in the way of* **daily bread for themselves.**

*The name* "**acorn**" *points to this; for* "**Ac**" *is only another name for* "**oak**"; *so that* "**acorn**" *is simply* "**oak-corn.**" *It is also known in some parts as* **oak-mast.**

*As civilisation advanced, man abandoned this rough and ready food* **for wheat and other things,** *while* **swine took his place in the woods,** *and fed upon the acorn crop, which he no longer needed.*

1. **The Oak-Apple.**—*Pick some of these, and compare them with the acorns. The children know them by their familiar name of* **oak-apples.** *Tell at once that these are* **not the fruit of the oak**—*that they are* **not apples at all.**



The oak bears **only one kind of fruit**; that is **the acorn.**

What then are these so-called oak-apples?

*Let the children examine them.*

They are **hard, smooth,** and **round,** and about **the size of a large marble.**

2. *Cut one of them open, and show* **the grub inside.**

*Remind the children of the immense numbers of insects, which* *go to the oak for support.* (This tree is said to support no fewer than **2000 varieties of insects.)**

One of these insects is the **gall-fly.** With its egg depositor **this insect pierces the skin** of the leaf-stalks and young shoots of the tree, to make a place **to lay its eggs.**

3. The wound sets up a sort of irritation in the stalk or the twig, **causing it to swell** into **a round fleshy ball** at that spot, with the egg in the midst of it.

The ball itself is intended as **a store-house of food.** It is Nature's provision **for the grub, which is to come from the egg.** *Compare these* **oak-apples** *with the* **gall-nuts** *of commerce, and tell the purposes for which the latter are used.*

4. *Remind the children that oak-apples may be seen* **hanging on the bare twigs of the trees all through the winter.** *They were formerly very much sought after on the twenty-ninth of May—Oak-Apple Day.*

*Ask them to be on the look-out for the oak-apples next spring. They will then find them* **hard, brittle,** *and* **very light;** *and if they break one of them open,* **they will observe that the grub is gone,** *and that the inside is loose and spongy. It will* **crumble up into dust** *in their fingers.*

*Explain that, after the grub has* **eaten its fill,** *it changes, first into the* **pupa form,** *and then into* **a perfect insect—***a* **gall-fly;** *but* **it remains all the winter in this cosy ball,** *which is thus* **food-store** *and* **house all in one.** *It leaves the ball when spring comes.*

5. *Before passing on from this subject, call attention to the pretty* **"oak spangles,"** *which stud the* **under side of the leaves.** *These are also* **the work of the gall-fly;** *they are similar in nature to the oak-apples themselves, except that they are formed* **on the leaves,** *the oak-apples* **on the stalks.**

**Beech-mast.**—*The children are all familiar with this* **fruit of the beech,** *as another autumn dainty for the pigs.*

*The ground at the foot of the tree is, of course,* **strewn with beech-mast now.**

*Gather some, and note as the result of investigation that :—*

(*a*) The beech-nut is **a sort of oval ball,** covered with **soft spines on the outside.**

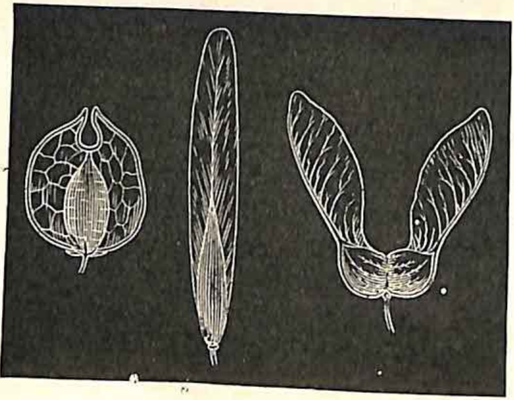
(*b*) When it is cut open, **the inside** is found to be **delicately smooth and silky.**

(*c*) It contains **two three-sided nuts,** joined together at their base.

(*d*) The nuts have **a sweet taste,** not unlike that of the walnut.

*Purposely leaving the children to tell what they already know of the hazel-nut, pass on now to consider :—*

THE WINGED SEEDS.—*The children are all familiar with these* "**Locks and Keys,**" *as they are termed—the fruits of the* **elm, ash, birch, maple,** *and* **sycamore.**



ELM. ASH. SYCAMORE.

*Find specimens of as many of them as possible now for examination and comparison, and note that :—*

(*a*) Each one is **a sort of nut,** containing a seed ; but attached to the nut is **a thin web or skin,** which we call **the wing.**

(*b*) The seeds of the **elm, ash,** and **birch** are **single,** and have a **single wing.**

(*c*) Those of the **maple** and **sycamore** are **in pairs,** and have **a pair of wings.**

*Note Nature's provision in these winged seeds. They are* **easily scattered by the wind.**

THE FEATHERED SEEDS.—*This will naturally lead to an examination of the seeds of the willow family— the* **willows, poplars,** *and* **aspens.**

*Collect, as specimens of these, a few of the seed-vessels of either the* **goat willow,** *or the* **common white willow,** *and let the children examine them. They will find that :—*

(*a*) The seed-vessel (carpel) **contains a number of seeds.**

(*b*) Each seed is **furnished with a tuft of fine hairs.**

*Compare these tufted seeds with the winged seeds above.*

When the ripened seed-vessel bursts, and these seeds are set free, what will happen to them?

### SUMMARY OF THE LESSON

1. The leaves of the ash, beech, birch, elm, and poplar assume varying shades of yellow as they fade in the autumn.

2. The leaves of the oak and hornbeam change from green to brown.

3. The sycamore leaf changes from green to yellow, then to golden brown, and lastly to a bright red.

4. Trees which shed their leaves in autumn are known as deciduous trees. Evergreens keep their green foliage all through the year.

5. The acorn and beech-mast are nuts.

6. The oak-apple is not the fruit of the oak.

7. The fruit of the elm, ash, birch, maple, and sycamore are winged seeds.

8. The willow family produce feathered seeds.

## Lesson XXXIX

# EVERGREEN TREES—PINES AND FIRS

### TIME—LATE AUTUMN

### I. INTRODUCTION

1. *PINES and firs are not natives of this country. Their true home is farther north. In those northern lands they grow and thrive naturally; they scatter their seeds and propagate themselves, as our timber trees do here.*

*But those which we see in this country* **are planted by man,** *who of course selects the most suitable spots he can find for his plantations.*

*Hence although we meet with these trees in many parts of the country, they are* **not to be found in every wooded district,** *as the oak, elm, ash, beech, poplar, and willow are.*

2. *Wherever there are any pine-woods in the neighbourhood, the teacher should take the children to visit them, so that they may observe the trees at first hand; and perhaps the most effective time for this visit would be in the late autumn, when all the other trees are bare and leafless.*

*In districts where this is not possible, and the lesson has to be given in the school-room, good pictures and specimens must of course serve instead.*

*Whether in school or during an outdoor ramble, proceed as follows:—*

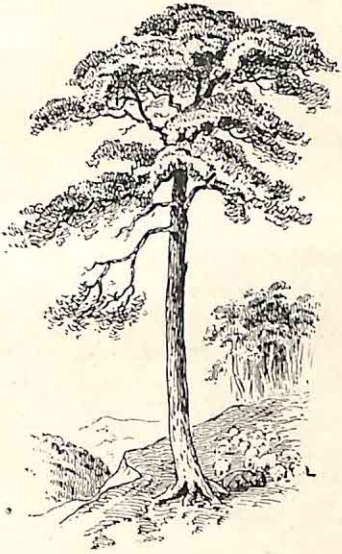
### II. GENERAL APPEARANCE

1. PINES.—*Point out the* **Scotch pine,** *and tell its name. Explain that it is the only one of the family which, properly speaking, belongs to Britain—and that it grows in a natural state only among the northern Highlands of Scotland; it is*

never met with in **England** except in parks and plantations.

*Lead the children to compare it, in its general appearance, with other trees of a more familiar type.*

2. The stem or trunk is **a very tall, straight, tapering pole,** with a **crown of branches at the top.** The



SCOTCH PINE.

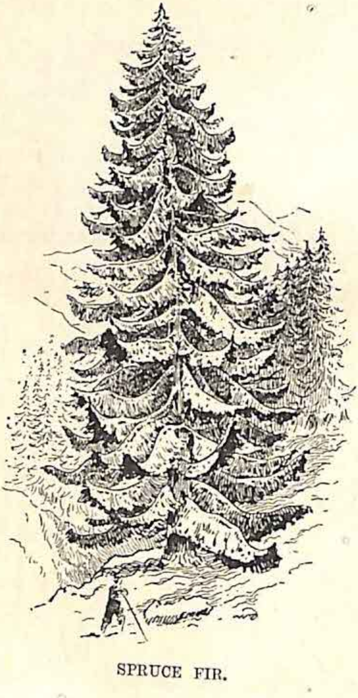
branches themselves spread out, so as to give the head of the tree **a flattened form.**

The monotony of the endless rows of these straight poles in a close-set pine plantation makes **a somewhat gloomy picture.**

1. FIRS.—*Compare and contrast the growth of these pines with the* **conical steeple-shaped habit** *of the* **spruce fir** *—which is* **a type of the true firs.**

These trees, with their **feathery branches drooping** to the ground, are **more beautiful and elegant** in appearance than the pines. But they are rarely seen in England; their natural home is on the hilly slopes in Norway.

They delight in a cold soil, and a sheltered hill-side.



SPRUCE FIR.

2. *Point out that the name* "**Fir**" *is often used in error for both classes of trees. The distinction between the two is clear, however:—*

The **wide-spreading flat-headed trees** are **pines**; the **conical, steeple-shaped ones** are the **true firs.**

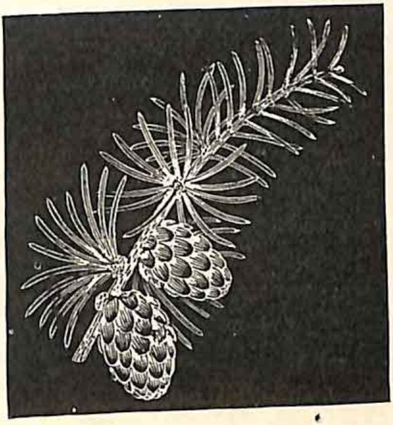
### III. LEAVES

1. *Proceed in the next place to consider the leaves, using for illustration, where it is possible, actual leaves collected on the spot.*

*Show the leaves themselves, or failing them, the picture, and let the children compare them with the leaves of other trees, with which they are now familiar. They will discover that* these strange-looking leaves are **mere spikes or needles.** They have **no blade** and **no footstalk,** such as the leaves of other trees have.

2. *Tell that they are known as* **needle-shaped leaves.** *They are found only on trees belonging to this group.*

They spring from the branches **either singly** (as in the spruce fir), **in pairs** (as in the Scotch pine), or **in thick clusters** (as in the larch and other members of the family).



3. *Notice Nature's provision in these needle-shaped leaves.* They are intended to protect the tree from injury

**The natural home** of all these trees is **in the cold northern regions** of the world.

**Large broad leaves** would afford a **lodgment for the snow** in winter, and the weight of this mass of snow resting on the branches would bear them down, and tear them off.

Then too, with such leaves, the trees would be **very liable to be uprooted by the violent winds**, which blow in those regions.

But, as it is, **the snow falls through these needle-shaped leaves,** instead of lodging on them, and **the most violent of winds blow through them,** with the least possible damage, for there is nothing to oppose their fury.

4. *It would be interesting and instructive at this juncture* **to find a larch,** *if possible.*

*It is an* **elegant conical-shaped tree,** *closely resembling the spruce fir in general appearance.*

*The children will at once notice that* **this tree is bare of leaves.**

**All the rest of the family,** pines as well as firs, are **evergreens.** That is to say, the new leaves always make their appearance before the old ones fall off, and hence **the trees are always green.**

The larch is an exception to this, for like all other deciduous trees, it sheds its leaves every autumn. **It is not an evergreen.**

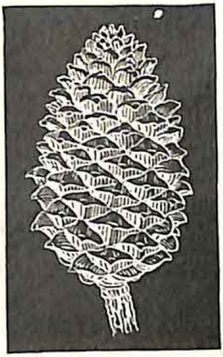
## IV. Flowers and Fruit

1. *Find some cones now, and proceed to examine them. (If the lesson is given in school, produce some specimens from the school museum.)*

*Tell that these are the fruit of the tree.* **Pines and firs of all kinds bear these cones.**

*The newly-gathered cones will probably be green. If so, select a few drier, riper specimens for closer inspection.*

2. *Notice that this peculiar fruit* **consists of a number of dry, hard, thick scales.**



It is really a great many fruits in one—for **each of these scales is a single fruit.**

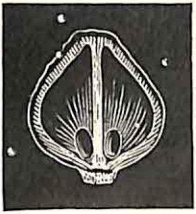
*Lead the class to tell that, in all plants, the fruit is simply* **the ripened pistil of the flower.**

*Explain that, in the case of these pines and firs, the pistil of each flower, instead of forming a hollow box or case for the seed, is* **simply a flat open leaf,** *joined like the rest to a common central stalk.*

*Strip the scales from one of the cones to show all this.*

3. As the cone ripens, these individual leaves **become dry hard scales**—such as we see in this pine cone.

In this scale-like pistil too **the seed is not enclosed** in a seed-case, as we find it in most plants. It is simply **attached to the upper surface of the pistil-leaf,** near the central stalk. *Hand some of the scales round, and let the children find the seed in each one for themselves.* We call it a **naked seed.**



4. When the cone is quite ripe, **the scales curl up,** and **the seeds** themselves **fall to the earth.**

*Explain that the fir and pine family are often described as* **the cone-bearing trees,** *because they are* **the only trees,**[1] **which bear fruit of this kind.**

5. *It will be sufficient for the present to describe (with the help of pictures) the flowers of these cone-bearing trees. Specimens*

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[1] The cedar belongs to the same group of evergreen cone-bearing trees. It is in many respects similar to the fir family.

*should be obtained in the spring, if possible, for inspection and comparison.*

Each tree bears **male** and **female flowers in short close catkins.** These flowers have **no attraction for insects** in the way of either **colour, scent,** or **honey.** The wind performs the duty of carrying the pollen of the male flowers to the ovule of the female flowers.

Such **dense clouds of pollen from the ripened anthers** are often carried by the wind, as to give rise to the expression **"showers of sulphur,"** which is familiar enough in the neighbourhood of these trees.

6. **The larch differs from the rest of the family** *in this respect. Its flowers, which come in April, hang at first* **in beautiful pink cones,** *but gradually assume* **a fine crimson colour** *before they die off.* They are not unlike a strawberry in appearance.

## SUMMARY OF THE LESSON

1. Pines are flat-headed trees; the true firs are conical, or steeple-shaped.
2. Pines and firs are evergreen trees. They have needle-shaped leaves.
3. The larch is not an evergreen. It sheds its leaves every autumn.
4. The fruit of pines and firs is cones.
5. The cone consists of a great many dry, hard; thick scales.
6. The seeds grow on the upper surface of these scales. We call them naked seeds.
7. Each tree bears catkins of male and female flowers.

## Lesson XL

## EVERGREEN PLANTS

### TIME—LATE AUTUMN

*THIS lesson, like many that have gone before, should be given if possible during the course of an outdoor ramble; but teachers in certain localities will not be confronted with the difficulty, which met them in dealing with the pines and firs, for unlike them, these evergreens are common in all parts of the country.*

### I. THE HOLLY

1. *Find this tree, and call attention first of all to its* **stiff sturdy growth.**

We often see it as a **mere shrub,** but under cultivation **it becomes a handsome conical tree,** sometimes reaching 50 or 60 feet in height. **It is the handsomest of all our evergreens.**

2. *Notice next the abundance of* **glossy dark-green leaves** *with which it is clothed, and the* **bunches of bright red berries** *clustered thickly round its young twigs.*

The holly-tree, as an evergreen, is **beautiful all through the year,** but when winter approaches, and its **clusters of coral-like berries appear,** it becomes the brightest ornament of our hedges and woodlands. As a tree it is **one of the most splendid objects in Nature.**

1. THE LEAVES.—*Pluck some of the leaves now, and let the children describe their form and general appearance:—*

They are **oblong and wavy,** with **sharp spines on their edges,** and they have a **smooth shiny surface.**

*These are the lower leaves; the upper ones, especially on an old tree, are as a rule without spines. Obtain one if possible for comparison.*

2. *By taking the leaves in their hands the children find that they are* **thick, tough, and leathery**; they will **not easily bruise or tear.**

*Proceed to deduce as follows*:—

(*a*) These leaves have to stand the winter. Nature made them thick, tough, and leathery, **to protect them against the frost and snow.**

(*b*) The smooth shiny surface is **Nature's provision for getting rid of the snow,** which falls on these leaves. A rough leaf would hold the snow, and the weight of it would damage the tree.

(*c*) The wavy form of the leaf **helps the snow and rain to slide off** easily.

(*d*) The sharp spines are meant as **a protection against animals,** that might otherwise eat the leaves.

(*e*) *Bruise one of the leaves, and let the children taste the bitter juice which comes from it. Tell that even insects seem to shun this tree. Scarcely a single plant has so few insect enemies as the holly.*

This is probably due to **the bitter taste of the leaves.**

1. THE BERRIES.—*Call attention to the berries once more. Tell that the flowers, from which these berries come,* **hang in white clusters** *on the tree* **in May.**

*Ask the children to remember this, so that they may be on the look-out for them, when they make their appearance next spring.*

*Hand round some of the berries now for examination by the class.*

They are rightly named "**berries,**" for when the **small round fruit** is opened, we find **the seeds** (four in number) **embedded in the pulpy flesh.**

2. *It may be possible to find several varieties of the holly—some under cultivation, the rest wild. There is one with* **yellow berries,** *and another with* **white.** *One kind again has its* **green leaves variegated with white or yellowish-**

**white patches;** *and another, known as* **the hedgehog holly,** *has the upper surface of the leaf, as well as its edges,* **covered with sharp spines.** *Hence the name.*

## II. THE YEW

1. *The church-yard will probably be the best place to look for this tree.*

*When one is found, let the children as before commence by observing the general appearance of the tree itself.*

*Notice first the peculiar habit of growth.*

It sends out its branches **almost horizontally** on every side from its stout sturdy trunk; and these are **thickly clothed with very dark green foliage.**

2. *Point out that,* like the holly, it is **an evergreen,** but it is not so pleasing in appearance as that tree.

The extremely dark green colour of its foliage gives it **a sombre look,** in spite of the **bright scarlet fruits, which it bears at this season of the year.**

*Tell that the yew* has long been considered **the funeral tree**—the most fitting ornament for the grave-yard.

THE LEAVES.—*Proceed next to examine the leaves.*

They are **long, narrow, stiff, and blunt-pointed.**

They stand up like **spikes** all over the branches. *Compare them with* **the spiky leaves of the pines and firs.** *Both have to* **stand the frosts and snows of winter.**

*Tell that the leaves of the yew are* **very poisonous to cattle and horses.**

1. THE FRUIT.—*Notice in the first place how peculiarly these grow* **on the sides of the branches** *themselves*—**not on separate twigs.**

*Tell that the flowers, from which these fruits come, make their appearance* **in May.** *They spring* **in clusters** *from the sides of the branches.*

2. *Collect some of the fruits for closer examination now. Observe that they are rather* **soft and sticky to the touch.** *Compare them with the holly berries.*

*Open one of them, but before doing so remind the children that we have purposely avoided calling it a berry. Show that instead of loose seeds embedded in a pulp, we find here a sort of stone.* **The fruit of the yew is not a berry; it is a small stone-fruit.**

## III. THE MISTLETOE

1. *This plant, like the holly, is familiar to all from its connection with Christmas festivities, but probably few of the children have seen it growing.*

*Search for it now in its favourite situation*—**on the wild crab.** *Here it forms a striking object, and cannot easily be missed, for the tree itself is stripped of its own leaves, and that makes the* **golden-green leaves** *and* **pretty white berries** *of the parasite shrub all the more conspicuous.*

2. *Failing the crab, it may be found* **on the poplar, willow, ash, lime,** *and* **maple.** *But* **it is an error** *to associate the plant with the oak, as is commonly done. Indeed it is really* **a remarkable rarity to find it on that tree.**

*The children, of course, will be curious to learn the nature of this strange plant, for it is the only one of its kind known to this country.*

1. THE BERRY.—*Pick some of the berries, and examine them:—*

They are **real berries,** for on opening them we find **the loose seeds embedded in a soft pulpy juice.**

This juicy pulp is of a **sticky glue-like character.** (*The sticky substance called* **bird-lime** *is made from it.*) **The ripe berries** themselves are **very sticky.**

2. When the berries fall, some of them find a lodgment in the cracks or crevices in the tree, and there they are

**held fast by this sticky glue,** till the time comes for germinating.

The sprouting seed sends down its rootlets through the bark and into the tree itself. The plant from the very first **takes all its nourishment from the tree.** It lives on the tree. We call it **a parasite plant.**

## IV. THE IVY

1. *Visit the ivy next. Choose one that is clinging for support to some old tree.*

*Notice first of all that this plant, like the others we have visited, is* **an evergreen.** *It is crowded with* **glossy dark-green leaves**; *but the tree to which it clings is bare.*

Is the ivy a parasite plant like the mistletoe?

*Show that this plant* **has its real roots in the ground.** *It takes its nourishment from the soil*—**not from the tree.**

2. *Pull up, or cut away a young clinging stem of the plant, and call attention to the* **little white roots,** *all along the under side of it.*

What is the meaning of this? These little roots are sent out all along the stem—not for the purpose of feeding the plant, **but as hold-fasts.** They force their way into the tree or the wall, and then grow hard and woody. **The ivy clings to its support by means of these little roots on its stem.**

1. THE LEAVES.—*Proceed to examine the leaves next, selecting for the present only those within easy reach. Hand some of them round for inspection.*

*Notice that although* **the leaf is simple,** i.e. *all in one piece, it is* **a five-pointed blade.** *The five points are the extremities of the* **five lobes or divisions,** *which make up the leaf.*

2. *It will not be a difficult matter to find some other leaves, in which the lobes are* **lengthened out into long fingers,** *for*

*the shape of the ivy-leaf varies very considerably in different plants. Find one of these if possible.*

This one might better be called **a five-fingered leaf,** than a five-lobed leaf, **for the lobes are like long fingers.**

3. *Notice that all these ivy-leaves are* **thick and stout, smooth and shiny,** *like those of other evergreens, and elicit the reason for this.*

*Notice too that the leaf has a* **thick strong-looking foot-stalk,** *and* **stout ribs.**

*Elicit that it is a* **heavy leaf,** *and* **requires strong support.**

4. *Endeavour now to get* **a flowering spray** *from near the top of the plant. The children will probably be surprised to see* **the ivy in flower,** *and at this season of the year.*

*Tell that these* **clusters of pale greenish-yellow flowers** make their appearance in **September,** and generally **last till December.**

*Let the children examine them carefully, and note their* **sweet fragrance.**

5. *Tell that as the flowers die off, they leave behind* **clusters of small dark-coloured berries.** The berries remain on the plant all the winter, and **ripen about April.** These black, glossy, ripe berries provide **the first store of food for several members of the feathered tribe,** which return to us about that time, after their winter absence.

*Now lastly call attention to the leaves on this flowering spray.*

These have none of the five-lobed or five-fingered character of the lower leaves; **they are heart-shaped.**

### SUMMARY OF THE LESSON

1. The holly is the handsomest of all our evergreens. Its thick, leathery, glossy leaves are Nature's provision against the frosts and snows of winter.

2. The evergreen leaves of the yew are long, narrow, stiff, and blunt-pointed. Its white blossoms come in May, and it bears small stone-fruits in the late autumn and winter.

3. The mistletoe is a parasite plant. It takes its nourishment from the tree on which it grows.

4. The ivy clings by means of tiny roots which grow out from its stem. It blossoms from September to Christmas, and bears clusters of berries which ripen in the following spring.

5. The leaves are either five-lobed, or five-fingered. The topmost leaves are heart-shaped.

## Lesson XLI

# THE WOODY TRUNKS OF TREES

### A WINTER LESSON

The teacher will require specimens of oak and other stems, cut so as to show both upright and cross sections; an oak sapling of one year old; a recently-cut branch from some tree; specimens of pine and other woods for burning; and specimens of turpentine, resin, tar, and pitch. Needless to say, the tar required for the lesson is not the black coal-tar, but that which is commercially known as Stockholm tar.

### I. INTRODUCTION

1. *THE children, while visiting the trees with their teacher at the various seasons of the year, have been laying up a store of sound reliable knowledge, which they have gained in the best possible way, by actual observation.*

*This should now be followed by a lesson in the school-room, with the help of pictures, diagrams, and specimens,—first for the sake of recapitulating what has been learned in a practical way out of doors, and afterwards with the purpose of investigating the properties and uses of the woody trunk.*

2. *The teacher would make the work of recapitulation very interesting and effective, by first sketching the leaf of a certain tree on the black-board, and then calling upon the class to name and describe it, and the tree to which it belongs.*

*Question out rapidly any peculiarities of the leaf—in* **shape, edges, veining,** *and* **arrangement**; *and then pass on to elicit all that can be told of the tree in its flowering season.*

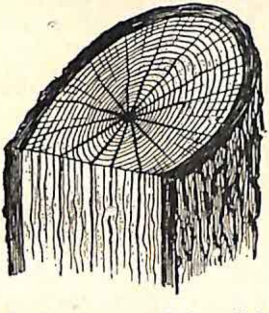
Does it blossom **before** or **after budding ?** Are its flowers **perfect** or **male** and **female** ? Do they hang in **catkins** or otherwise ? Are the male and female flowers **on the same** or **different trees** ?

3. *This will naturally lead up to the fruit, or seed-vessel, which is left behind when the flower dies. In one case it is* **a nut,** *in another* **a winged seed,** *in another the seeds themselves are* **tufted with hairs.** *Have each one in turn briefly described, and illustrated with black-board sketches, pictures, and specimens.*

## II. Nature of the Trunk

1. How it Grows.—*Show a piece of the* **stem** *or* **branch** *of some tree—an oak will be best perhaps for the purpose.*

*Call attention first to the* **thick rough coat** *or covering on the outside. Dig a knife into it, and show that it is* **much softer** *than the wood itself. It is* **more like cork** *than wood.*



*Elicit that* this is **the bark.** It makes a **thick top-coat** to protect the tree.

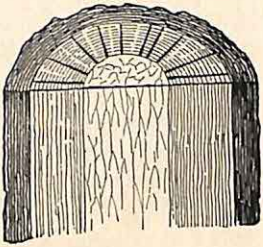
2. *Notice the wood next. The stem is made up of* **rings** *or* **layers one inside the other.**

*Let one of the class try to force the point of the knife first into the middle of the stem, and then into the outside part—just under the bark.*

*He learns that* **the middle or inside part** of the stem is **much harder** than the part on the outside.

Let us see if we can find the reason for this.

3. *Show a piece of a* **a one-year-old sapling oak.** *Tell what it is, and call attention to the* **thick greenish-white cord,** *which takes up the whole of the* **central part of this stem.**



*Let the children examine it, and they will find that it is* **a soft spongy** *kind of substance, with* **a hard woody ring or layer all round it.**

*Explain that this central cord of soft matter is known as* **the pith,** *and that it is always very thick in young trees.* **It extends through stem and branches as well.**

4. *Tell that* **the dissolved earth-food,** *which is absorbed from the soil by the roots,* **rises upwards** *to the leaves* **through this central pith.**

Why must this earth-food flow up to the leaves? Because the leaves have to take in **air-food** to mix with it, before it can be fit **to feed the plant.**

What do we call this watery liquid which flows through plants? We call it **the sap.**

1. SAP-WOOD.—*Explain that this sap, after flowing through the leaves,* **returns again along the twigs, branches, and stem,** *and that it always flows back on the outside of the wood,* **between the wood and the bark.**

From this fluid **a new layer of woody matter** is formed during the growing season. It is at first **soft and pulpy,** but it hardens into actual wood in time. We call it **the sap-wood.**

2. *Tell that if during the spring and summer a branch is cut*

*from a growing tree, and the bark is stripped off, we always find* **a thick sticky liquid** *just under the bark.*

*Show a newly-cut branch of some tree now. Strip the bark from it, and point out that* **it is almost dry.** *We find* **no sticky liquid** *there now.* How is that?

*Remind the children that the leaves are now all fallen, and explain too that the* **sap has ceased to flow.** The tree is resting. When spring returns it will wake to new life, and **then the sap will flow once more,** and new leaves will bud.

1. HEART-WOOD.—*Return to the sapling stem now, and explain that* the hard woody layer round the thick pith of this one-year-old stem is **the wood which has been formed this year.** But if it had been left to grow, we should have seen next year, and each year after, **a new layer of wood formed outside this.**

These rings or layers of new wood, growing one by one, **press upon the pith all round,** till at last it becomes **a mere thread.** We can see, in the older piece of oak-stem, only the spot in the centre of the woody rings where the pith once was.

But what do these rings themselves tell us? They tell us **how many years the tree has been growing,** because there is **a new layer of wood formed every year.**

2. *Notice, in connection with this, that the rings or layers of wood are not all the same thickness.* The layer formed in one year **may be thick, the next year's layer thin,** and so on.

*Explain that, by observing these rings, we can not only tell how many years the tree has lived, but* we can **pick out the wet seasons from the dry ones.** More sap rises in a wet summer than in a dry one, and hence **more wood is made. The layer of wood formed in that year is a thick one.**

3. *The children will now readily deduce from what they have seen that:—*

(*a*) **The centre** of the stem is **the oldest,** and **the sap-wood** the **newest formed wood** in the tree; the tree **grows on the outside.**

(*b*) This **central part becomes harder** than the rest, because of the growth and pressure of the other woody layers round it year after year.

4. *Tell that the wood in the centre of the stem is known as* **the heart-wood.** *It is always* **the hardest wood in the tree.**

*Explain that all our British trees grow in this way, by adding* **each year a ring or layer of new wood on the outside** *of the stem, just under the bark.*

## III. Firs and Pines

1. Resin and Turpentine.—*Hold a piece of pine-wood in the flame of the spirit lamp.* It quickly takes fire and blazes up, **burning with a smoky flame,** and giving out **a peculiar, strong smell.**

*Now hold pieces of oak, ash, beech—any of the woods except pine or fir—in the same flame, and let the class observe how these act.* They all burn, some more quickly than others; but **none of them** blaze up fiercely **with a smoky flame,** as the pine-wood did; **none of them give out the powerful smell,** which we noticed when that was burning.

2. *Ask the children to smell the specimens of pine-wood, and then hand the bottle of turpentine round the class, so that they may also smell that. They find that the liquid in the bottle has* **the same smell as the wood.**

*Pour a drop or two of the liquid on a piece of paper, and put it in the flame of the lamp.* It blazes up, **with the same smoky flame** as the piece of pine did.

*Ask for the name of the liquid.* It is **turpentine.**

So then there is **turpentine in this wood.** How did it get there?

3. *Call attention to the wood itself, and the* **darker-coloured markings** *in it. Explain that* **turpentine is the natural juice** *or* **sap of pines and firs**; *it is the turpentine in the wood which makes these markings; it is* **the turpentine** *in it that* **burns and smells.**

*Tell that pines and firs are the only trees which have this peculiar sap. It is this which gives the* **unmistakable smell to a pine plantation.**

4. All the turpentine we use comes from these trees. It is obtained by piercing holes in the bark of the tree. The liquid which flows out of these holes is **thick, very sticky,** and **of a yellowish colour**; it is **not unlike honey in appearance.** As it flows out, it is caught in vessels hung below the holes to receive it.

This liquid is known as **crude** or **common turpentine.** It is boiled in a copper retort. Some of it **changes into vapour,** passes off into a cool chamber, and there **changes back again into the liquid form.** But it is **a thin clear liquid** now—like this in the bottle. We call it **spirits of turpentine.**

5. When the boiling is over, **a brownish-yellow solid substance** is left in the retort.

*Show the specimen of resin, and let the children tell what it is.*

This **resin is the solid substance left behind,** when the clear liquid turpentine has been removed by the boiling (or distilling, as it is properly called).

*Tell that* **pines and firs** *are sometimes called* **resinous trees.**

1. Tar from Pines.—Certain members of the pine family yield **tar.** The tar, however, **does not flow naturally** from the tree as turpentine does. It is **stored up in the roots,** and the supply can only be obtained **by the destruction of the tree.**

The tree, when fit for the purpose, is **felled,** and **the roots are cuts up** into small logs. A circular pit, tapering towards the bottom, is next dug on a sloping bank or hillside. The sides of the pit are beaten hard and smooth, and it is **connected by a pipe with a tank** placed below.

2. The little logs of pine-roots are then carefully packed in the pit, and when it is full, **a fire is lighted on the top.** Then as soon as **the whole mass is fairly ignited,** the mouth of the pit is **covered with earth and turf.** The burning goes on in a slow smouldering sort of way, **because it is smothered and confined.**

The wood becomes charred and **converted into charcoal,** and **a dense treacle-like liquid** runs downward through the pipe into the tank below. **This liquid is tar.**

This **crude tar** when heated in the retort **distils over,** and leaves behind the **black solid substance** which we know as **pitch.**

3. *Ask the children to note, as a curious fact in connection with these pines and firs, that whenever we visit a pine plantation, we find only* **a very scanty vegetation** *beneath the trees.*

*Tell that this is due in a large measure to the* **resinous nature of the fallen leaves,** *which makes them* **destructive to nearly all other plants.** *Hence the pines themselves are left in sole possession of the soil, because they alone can live there.*

## SUMMARY OF THE LESSON

1. The woody trunks of trees grow by forming every year a layer of new wood outside the last layer.

2. The wood in the centre of the stem is the hardest wood in the tree. It is called the heart-wood.

3. The newest-formed layer is known as the sap-wood.

4. Pines and firs are resinous trees. They yield turpentine and resin.

5. Some of the pine family yield tar and pitch.

## Lesson XLII

## TIMBER AND WOOD

### (A Sequel to the Last Lesson)

### I. Properties

1. *Produce the specimens of the various woods from the school museum, and proceed to investigate their properties as follows:—*

*Place them in a large bowl of water, and observe that the specimens of* **willow** *and* **poplar float high out of the water**—*higher than the* **pine** *and* **birch—much higher** *than the* **ash, beech, elm,** *and* **oak.**

*The* **oak floats with its upper edge almost on a level with the surface of the water.**

*Deduce from this that* **willow and poplar are the lightest**—*ash, beech, elm, and oak* **the heaviest—of these woods.**

2. *Take them all out of the water now, and set one of the boys to cut them with a knife.*

*He finds that* **the light woods are softer,** and cut more easily than the heavier ones.

3. *Pass them round the class now, and let the children handle them. They find that* the heavier, harder kinds are **dense and close-grained,** the light soft woods **looser in texture.**

*Explain that the different properties of the different woods make them suitable for many useful purposes.*

4. The trunks of all our trees yield wood. The only distinction between timber and wood is that, **the timber trees** are so large that, their trunks may be **sawn up into immense pieces,** not only long, but **wide and thick** as well. Such pieces of wood we call **logs or balks of**

**timber.** They may be used in that state, or they may be **sawn up into planks.**

5. In any case, by the term timber we mean **great balks** or **planks of wood,** which from their size and quality are **fit to be used for building** and other purposes where **strength and durability are the main objects.**

Among the chief of these timber trees are the **oak, beech, cedar, ash, elm, pine, larch,** and **hornbeam.**

The various **ornamental woods** used by the cabinet-maker form a class by themselves, and are not included under the head of timber.

Among these are the **box, apple, cherry, holly, walnut,** and **maple.**

### II. Uses—Timber

*Proceed now to deal briefly with a few of the principal woods, as follows :—*

White Willow.—*Let the children handle and examine the specimen. They will readily describe it as a* **light soft wood.**

*Explain that although light and soft, it is* **very tough and elastic,** so that it **does not easily split from any sudden shock.** This makes it very **suitable for lining stone-carts** and **barrows.**

It is also used in **mill-works, turnery,** and **coopery,** and for **building small boats.**

Its lightness, too, specially fits it for **the handles of hay-rakes,** and **other farm implements.**

White Poplar.—*Have the specimen examined as before.*

This is another **light, soft, smooth wood** ; but it is **so tough** that nails may be driven into it near the edge **without causing it to split.**

*Tell that because of this it is* much used for **making packing-cases.**

BLACK POPLAR.—*Hand the specimen round, and note that the name* "**black**" *has nothing to do with the colour of the wood.*

*Observe that it is* **very light,** *and tell that because of this it is used for making* **bowls, platters,** *and* **butchers' trays.** *Show some article if possible.*

ELM.—*Let the children examine the specimen. They will describe it as a* **rough, heavy, cross-grained wood.**

*Tell that it is* **very tough and strong,** *and* **does not easily split.**

*Explain too that* it will **last longer under water** than almost any wood; but it soon rots if it is subjected to frequent changes from wet to dry.

Elm is largely used for **country carpentry,** where **toughness and strength** are the chief requirements. **Wheels for water-mills** are made of elm, and so are **pumps** and **heavy carts. The wheelwright uses this wood** for the **naves of his wheels.**

ASH.—*Let the children handle and examine the specimen.*

*Tell that* this is a **very pliant wood.** It ranks **next to oak for strength, toughness, and elasticity.**

It is the **principal** wood of **the wheelwright** and **the agricultural implement maker.**

**The wheelwright** uses it for the **spokes of wheels** and the **shafts of waggons** and other vehicles; and its **lightness and elasticity** combined make it the best of all woods **for the handles of tools,** where shocks and wrenches have to be provided against.

It is also used in the cabinet trade **for bedroom furniture.**

BEECH.—*Compare this specimen with the last, and point out that it is a heavier, denser wood.*

It is **hard** and **close-grained,** and has **a smooth, even surface.** In closeness, toughness, and strength it is **almost equal to oak.**

*Tell that it is largely used for making* **cogs for mill-wheels.** *But it requires to be kept either very dry or very wet.* In damp situations it quickly rots.

It is also used for making **chair-backs, rails,** and **legs,** and **the tops of benches.**

OAK.—*Examine several specimens of this wood if possible, to show the grain.*

*Tell that* as the tree itself is **the monarch of the forest,** so **its wood** is **superior to that of all others.** It is the **strongest** and **most durable** of our British woods; it suffers less than any other from water or atmospheric changes.

It is highly prized for **shipbuilding purposes**; and from the earliest times it has been used for making **the roofs, pulpits,** and **seats in churches** and other buildings, which are intended **to last for a long time.**

CEDAR.—*Hand the specimen of cedar wood round the class for the children to smell.*

The chief property of this wood is that, it is proof against all attacks from grubs and other vermin, owing no doubt to the peculiar bitterness of its resinous juices.

*Remind the children of the importance of this tree among the ancients, as shown by the use that was made of its timber for building.* The **"cedars of Lebanon"** provided an important part of the material for the building of **King Solomon's Temple** at Jerusalem.

We use the wood now mostly for **lead-pencils** and **cigar boxes.**

HORNBEAM.—This is a **very white, tough, and strong wood.** It is used for **tool-handles,** and **cogs for wheels**; and it is also **much prized by the turner,** because of its close grain.

FIR AND PINE.—The fir and pine family are perhaps the **most valuable of all our timber-trees,** because they are plentiful, and therefore cheap. The wood of these trees is not so strong, nor so durable, as many other kinds of timber; but it is **easily worked.**

The family comprises a great variety of trees.

The most durable among them are the **larch,** the **pitch-pine,** and the **firs** of Norway, Sweden, Russia, and Germany.

These trees yield **resin, turpentine, tar,** and **pitch.**

The **white** and **yellow pines** of the Canadian forests are not among the strongest and most durable of woods; but **they are much in demand in this country, because they are so easily worked.**

The **Scotch pine** yields **a very valuable timber,** little inferior to oak. It is obtained from Scotland, Sweden, Norway, and Russia, and is frequently named **red pine, red deal,** and **Riga fir.** The **spruce** and **silver firs** are employed largely for making **ladders, masts of ships, scaffolding,** etc.

*Show specimens of as many of these woods as can be obtained.*

## III. USES—ORNAMENTAL WOODS

MAPLE.—*Produce the specimen of maple (polished if possible), and let the class examine it.*

*Notice that it is a* **smooth, close-grained yellow wood,** and that in its finished state it has a **very rich appearance.**

*Tell that the* most beautifully veined and spotted wood comes from **the knotty parts of the stem and roots.**

This wood is much prized in **cabinet-work** and **turnery** of all kinds.

WALNUT.—*Have the polished specimen examined as before, and lead the class to describe it:—*

It is a **dark-coloured wood,** beautifully **veined and**

**marked,** and, like maple, it is capable of taking **a very high polish.**

*Tell that the* **richest and finest wood** comes from **the knotty parts** of the trunk **near the roots** of the tree.

This beautiful wood is **much used by the cabinet-maker,** and also for **inlaying** and **ornamental work** of all kinds.

Another important use of walnut wood is for the **making of gun-stocks.** It is specially suitable for this, as **it is light** as well as **strong.**

Box.—*Let the children examine and describe the specimen as usual.*

It is a **yellow, hard, smooth, close-grained wood.**

*Show an ordinary two-foot rule, and explain that box is the wood generally employed for making these, and all sorts of delicate* **instruments for measuring purposes.** It is also much used for making **toys,** and in many kinds of **carving** and **turnery work.**

Holly.—*Show the specimen—a piece of the polished wood if possible.*

*The first thing to arrest the attention of the class will be its colour.* It is white. **It is the whitest of all our hard woods.**

*Notice the extremely* **fine smooth texture** *of the wood. Point out too that it is* **very hard,** *and that it takes a* **high polish.**

In its polished state **this wood is not unlike ivory.**

*Tell that it is much used for* **veneering,** *and for* **inlaying amongst darker woods.**

**Handles for metal tea-pots** *are made of holly wood, and when stained black they* **look like ebony.**

Holly wood is also used in **carving** and **turnery** work, and for **various kinds of instruments.** The **handles for the best riding-rods** are generally made of holly.

### SUMMARY OF THE LESSON

1. The wood of each tree has its own special character. One is light and soft; another heavy, hard, and close-grained. Each has its special uses.

2. Timber is the wood of large trees. It is used for building purposes, because of its strength and durability.

3. Ornamental woods are valuable for the beauty of their grain, and the high polish which they are capable of taking.

4. Oak, ash, beech, elm, and pine are the most valuable among the timber trees.

5. Walnut, maple, box, and holly are the most beautiful of our ornamental woods.

## Lesson XLIII

## AMONG THE FERNS

Specimens collected during the ramble will provide the necessary illustration. A good magnifying glass and a bell-jar are all the teacher will require in school.

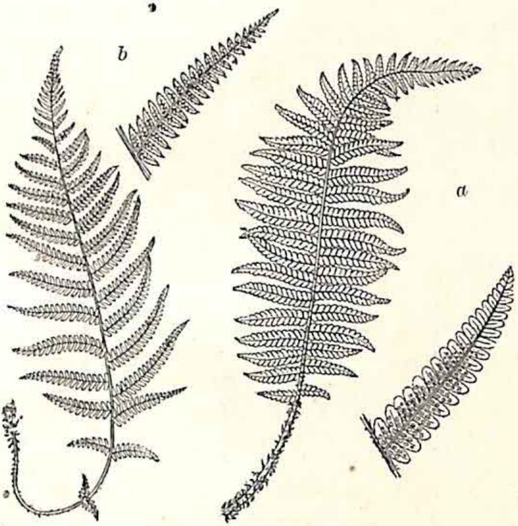
### I. FRONDS FOR LEAVES

*DURING one of the earlier rambles the children were promised a day with the ferns, and now they understand the common nature of ordinary plants, it would be a fitting time to redeem that promise. The manner of doing so, however, must depend upon the* **character of the locality.** *In one district the* **woods** *and* **warm shady lanes** *abound in* **ferns of many varieties,** *large and small; in another the* **hill-sides** *and* **heath-lands** *are clothed with a still greater profusion of the* **common brake fern** *or* **bracken.**

*But even in places where wild ferns are comparatively scarce, the teacher would have no difficulty in introducing* **a few specimens into the school-house garden** *for the* **purpose of illustration.**

*Where it is possible, however, select a suitable day for the ramble, and take the children along the green shady lanes and other suitable places, in order that they may observe for themselves the spots, where these plants grow in greatest profusion. But they will probably require very little guidance in this, for most boys and girls know where to go for these things.*

Ferns delight in **moist, warm, shady situations.**



(*a*) MALE FERN, AND (*b*) LADY FERN.

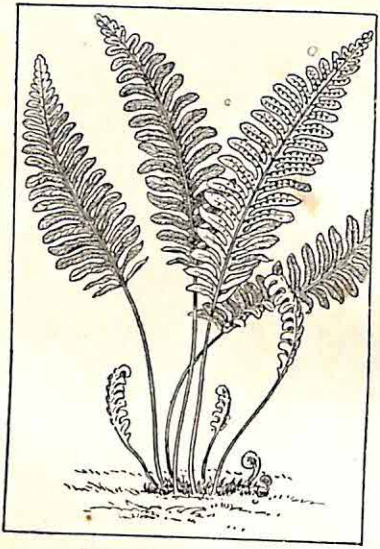
Hence we find them growing **on the banks, in the hedges among the weeds, in the ditches, in the woods,** and even **peeping out between the stones** by the roadside, and from the **cracks of old walls,** wherever it is shaded by the trees and bushes.

*Collect as many varieties as possible, and call attention to the variations in form.*

These beautiful fern leaves are called **fronds.** Some of them are **feather-like** in appearance, for they have an **immense number of long narrow leaflets,** which form

**a sort of fringe on either side of a central mid-rib,** each leaflet being itself **similarly barbed.**

Others have **long narrow leaflets** on both sides of the mid-rib, but the **edges of the leaflets are smooth;** and others again have leaflets of **various shapes and sizes.**



COMMON POLYPODIUM.

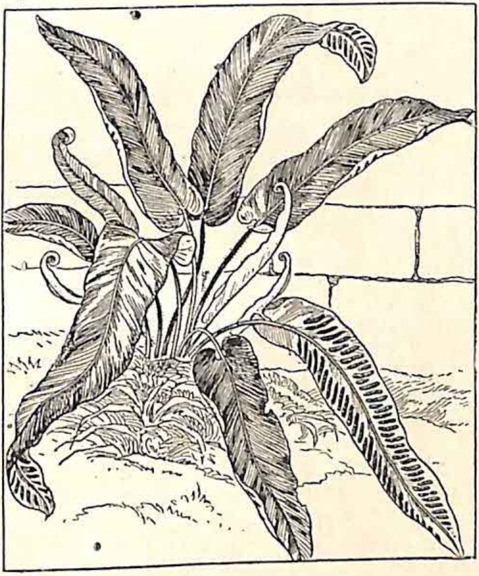
The fronds of another kind, instead of being fringed with leaflets, are **all in one piece,** like **a long narrow ribbon.**

Some are only **a few inches** in length, others measure **as many feet;** some are **thin and delicate,** others are **thick and tough;** some are **pale-green,** some **dark-green,** and some **almost brown.**

*It is neither possible nor desirable, in the scope of this lesson, to attempt to name any of the varieties of the fern family. The teacher will select and name a few of those best known to the locality.*

*Hold one of the fronds up to the light now, and ask the children* **to find the veins in it.** *They will observe that, like other leaves,* **it has veins,** *but the veins, instead of forming a network through the leaf,* **run in straight parallel lines to the right and left of the mid-rib.**

*Dig up one of the growing plants now, clear away the soil from it, and point out that the thick solid part in the ground is not the root, but* **an underground stem, or root-stalk.** *Show the* **real fibrous roots** *which hang down from it.*



HART'S-TONGUE FERN.

*Notice the* **buds in the root-stock** *from which the fronds spring, and remind the children that* **buds are never found on real roots.**

*Call attention, in the next place, to the young fronds which are just bursting out from this stem.*

They are **coiled up tight** into the form of a **ball,** and covered with **a thin brownish sort of skin,** which **splits as the young frond increases in size.** As the coiled-up frond pushes its way above ground, it has something of **the form of a bishop's crozier.**

In every case the fronds **spring direct from the underground stem**; there is **no stem of any kind above the surface.**

MAIDENHAIR FERN.

*Call attention to the* **branching nature of the common bracken,** *and compare it with the other ferns.*

This is **one of the very few members** of the fern family which **throw out branches.** Still it is important to remember that the part which branches **is not a stem,** but the mid-rib of a frond. It comes from the underground stem, and sends out branching fronds in all directions. The true **underground** stem creeps along below the surface for some distance, and sends up fresh fronds as it goes.

*Cut through one of these stout stalks with a knife, and point out that,* **instead of the woody ring and a central pith,** *such as we should find in the twig of a tree, it is made up entirely of* **parallel bundles of woody fibres packed close together without any central pith.**

## II. SPORES FOR SEEDS

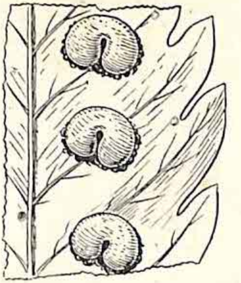
*Point out in the next place that none of these strange plants bear flowers*—**ferns are flowerless plants.**

*Lead the children to tell that without flowers there can be* **no fruit, or seed-vessel,** and therefore **no seeds,** *such as we find in other plants.*

Then how do such plants grow and multiply, if there are no seeds to produce young ones?

*Call attention to the under surface of one of the full-grown fronds, and point out* **the little specks** *or* **patches** *on it,* **set side by side** *in regular order.* **They are brown when quite ripe.**

In most ferns these brown specks are **round** and **quite separate,** and they are **arranged in double rows** on the back of each leaflet of the frond. But in some, such as the ribbon-like **hart's-tongue fern,** the specks are set so close together that **they form long continuous ridges,** stretching from the mid-rib **to both margins of the frond.** *Show this of course.*


SPORE-CASES (MAGNIFIED).

*Select now a mature frond, and show that these brown specks* **will easily rub off in a sort of powder.** *Tell that, if this powder be examined under a powerful magnifying glass, it is found to consist of* **an immense number of rounded cells or cases.** *Take the earliest opportunity of showing this after the return to school.*

These cases **split when fully ripe**, and set free **the actual seeds**, in the form of a very fine dust, which can only be seen with the help of a powerful glass. These curious seeds are known as **spores**, and the cases which contain them are called **the spore-cases.** They are **the actual seed-vessels.**

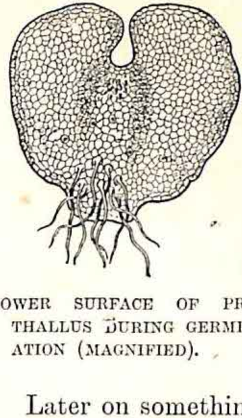
In each little brown speck on the back of a frond there are **hundreds and hundreds of spore-cases**, and each of these little cases **contains a multitude of spores.**

*The spores may be easily obtained in the autumn by leaving a mature frond to gradually dry up and wither on a sheet of white paper. As the spores-cases dry and split, the spores will be shed from them as a fine dust.*

## III. How Ferns Grow

*The development of young ferns from the spores is most interesting. It may be easily shown as follows:—*

*Put a little damp soil on a plate, rub off some of the spores from a ripe mature frond on it, and cover with a large glass bell-jar to keep in the moisture. It should be kept in an even temperature, and placed in such a position that the children may easily observe it from day to day.*



LOWER SURFACE OF PROTHALLUS DURING GERMINATION (MAGNIFIED).

In a short time a number of **small green rounded scales** make their appearance **on the surface of the damp soil.**

These scales send down into the soil from their under surface **a number of very fine delicate root hairs**; but they are **not ferns**—they are **nothing like ferns.**

Later on something is seen to be **growing upwards from the surface of the scale**, and as this new growth develops, it is found to be **a young fern**, which in time will **send out real fronds**, and **bear spore-cases** of its own.

*Point out from this curious development the difference between the fern-spore and an actual seed.*

When the true seed germinates, it develops at once into a plant exactly like the one from which it came. But the germinating fern-spore produces at first a peculiar growth, with nothing of the fern about it. **The real fern springs from that curious scale, which comes from the spore.**

*Sow some* **mustard-seed** *at the same time, and let the children watch its development by way of contrast.*

### SUMMARY OF THE LESSON

1. Ferns delight in warm, moist, shady situations.
2. Fern leaves are called fronds. They have many forms.
3. There is no stem above the ground. The stem is an underground root-stock.
4. The common bracken is the only fern that sends out branching fronds.
5. Spore-cases, filled with spores, grow on the under-surface of the frond.
6. Ferns never bear flowers, fruit, and seeds like other plants.
7. The spores which come from the spore-cases are the seeds of ferns.
8. When the spores germinate, they produce not a real fern, but a scale from which a fern will afterwards grow.

## ADDITIONAL INFORMATION FOR THE TEACHER

### BRITISH TREES

Besides the trees, which form the subject of the foregoing lessons, there are others which cannot be altogether passed over, although space will not admit of dealing with them in lesson form. Some, like the lime, sycamore, field-maple, and horse chestnut, belong to the town or the suburbs of the town, rather than the country.

Others, such as the walnut, and the eatable or Spanish chestnut, belong to the orchard and the ornamental park.

In order to make our list as complete as possible, the following items of information have been added here, so that the teacher may find material ready to hand, to guide him in framing lessons on any of these trees, which are to be met with in his own locality.

## THE LIME

The large-leaved lime, which is a familiar avenue ornament in the suburbs of all our towns, is rarely seen growing in a state of nature. Planted as an avenue tree, it is mostly cut, cropped, and stunted into regular form; but in parks, where it is allowed its free growth, the same tree frequently attains enormous dimensions,

In certain parts of the country we meet with another variety of the lime, which grows in a wild state in the woods. This tree is called the small-leaved lime, the leaves being much smaller than those of the common lime. It is a well-known tree in the woody parts of Essex and Sussex.

The lime is noticeable in the spring and early summer for the bright fresh verdure of its foliage, but the leaves assume a darker colour later in the year. They are large, heart-shaped, serrated leaves.

Later on (towards the middle and end of June) the flowering time comes, and the air all round is then perfumed with the rich fragrance of its blossoms.

The flowers, which are perfect, and not male and female, have five sepals, five petals, and a cluster of many stamens. They contain rich stores of honey, which is not only abundant in quantity but peculiarly fine in quality. Hence these trees are much frequented by bees and other insects during the flowering period.

In Lithuania, where there are whole forests of limes, bee-keeping is a special industry, and the honey obtained from these trees during the flowering period is so highly esteemed that, it fetches three or four times the price of ordinary honey.

The fruit of the lime is a one-winged seed.

The wood of the tree is yellowish white, soft, and smooth-grained. It is highly prized by the cabinet-maker, the turner, and the carver, and is largely used in toy-making, and for the sounding-boards of pianos.

The inner bark of the tree is macerated in water, till it separates into thin strips of "liber," "bass," or "bast," the well known material which gardeners use as matting to protect their plants.

## THE SYCAMORE

The sycamore in its prime is a handsome massive tree with a dense mass of foliage, which provides an impenetrable shade in the heat of the day. Hence it is often planted on the sunny side of the dairy for the sake of coolness.

The leaves, which are large, five-lobed, and serrated, are very beautiful as they expand in the spring, for they are then of a delicate transparent green, and if they are held up to the light they show rich tints of crimson and amber.

As the summer advances, however, swarms of insects infest and devour the leaves, giving them a ragged appearance. The tiny green-fly, or aphis, settles on these trees in countless myriads. This insect sends out from its body a sweet sticky liquid, commonly known as "honey dew," which covers the leaves and collects on them every particle of dust that floats in the air, so that by the end of the summer the foliage has lost its early beauty and assumed a dusty dirty appearance.

The blossoms appear in April. The flowers, which contain five sepals and five petals, grow in hanging tassels, and the fruit is a two-winged seed.

Autumn has few trees of richer and more varied tints than the sycamore. It begins to change earlier than most trees, and passes gradually from green to tawny, and from tawny to bright scarlet.

The wood is yellow in colour, and though firm it is not hard, so that it is easily worked. It takes a high polish, and is a favourite wood with turners, cabinet-makers, and violin and other musical instrument makers.

## THE FIELD MAPLE

This tree belongs to the same family as the sycamore. It has similar five-lobed elegant leaves; flowers of the same character, except that they are erect and not pendulous; and the fruit is a two-winged seed.

The sap of both the sycamore and the maple yield sugar. In Scotland the children amuse themselves by piercing the bark of the sycamore trees, and sucking the sweet sap which flows from the wound; and in North America maple sugar is an article of daily use. The wood of this tree has already been dealt with in Lesson XLII.

## THE WALNUT

This tree belongs rather to the orchard than the woodland. It is a large, handsome, boldly-branching tree, with elegant compound pinnate leaves, consisting usually of three pairs of leaflets, with one at the extremity—seven in all. Sometimes, however, there are nine leaflets—four pairs instead of three. They are oval in shape, smooth, and slightly serrated, and the early foliage is a bright pleasing shade of green.

The walnut tree flowers in June.

The same tree bears both male and female flowers, the male flowers hanging in catkins. The fruit is a sort of drupe, with a leathery outer covering, enclosing a shell, which contains a furrowed nut—the seed.

This tree is singularly free from insect pests—a fact due in all probability to the peculiar bitterness of the juices of the leaves and fruit.

The wood of the tree was dealt with in Lesson XLII.

## THE SWEET CHESTNUT

In its prime this is a grand colossal tree, to all outward appearance little inferior to the oak. But, strange to say, age, which gives solid strength and maturity to the oak, brings decay and rottenness to the chestnut, so that as a timber tree it is practically worthless.

The foliage consists of large, oblong, glossy-green, serrated leaves, and in the flowering season (end of May) the same tree bears both male and female flowers, the male flowers as usual hanging in long drooping catkins.

During the blooming season the flowers give out a powerful unpleasant odour, which is not only sufficient to render the tree offensive to people in the vicinity of it, but also has the effect of repelling insects. The consequence is that this tree suffers very little from the attacks of insects, so far as its foliage is concerned. The young tender nuts, however, do not escape so easily, for a kind of weevil often pierces them, and deposits its eggs in them—the nut itself of course providing the food store for the grubs which come from the eggs.

## THE HORSE CHESTNUT

The first thing to notice with respect to this massive stately tree is that it has no connection whatever with the real sweet chestnut, except, perhaps, that both trees produce nuts of somewhat similar character. Here, however, all resemblance ends, for while the fruit of the sweet chestnut is highly esteemed wherever it grows, and in some countries is actually used as a substitute for bread, that of the horse chestnut is bitter in taste, and not fit for human food, although it is sometimes given to animals.

The foliage of this tree, especially in April, when it first bursts open, is of a truly handsome character; but even before the leaves fully open, the great swelling buds give the tree a striking appearance.

The leaf is compound, and consists of seven leaflets—three pairs and a large one at the extremity, each leaflet being strongly veined and serrated.

In May, the flowering season, the tree is one of the most beautiful objects in nature. The blossoms, which are of a delicate white, and tinted with yellow and pink, are arranged in long upright spikes, not unlike a hyacinth in form. The tree itself is one huge bouquet of flowers.

From the rich elegance of its foliage and blossoms the horse-chestnut is especially adapted as an avenue tree; but beyond these ornamental qualities this tree has not much to recommend it, for its wood is soft and of little value, and its fruit is practically useless.

## WILD FLOWERS

*The children, during their outdoor rambles, from time to time, will of course continue to make collections of the local wild flowers, which should afterwards be pressed and named in a book for future reference.*

*The following items of information will no doubt be found useful to the teacher, in connection with the little informal chats which will be sure to arise therefrom.*

### LESSER CELANDINE, PILEWORT, OR SWALLOW-WORT

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Woodlands and moist pastures. | March, April, and May. | A perennial plant, with slender stems and heart-shaped leaves. The root sends out potato-like tubers, from which new plants spring. | The flower is a bright yellow star. The petals, which vary from six to ten in number, have a peculiar glossy surface. The calyx is formed of only three sepals. It is often mistaken, even by country people, for the buttercup. | The name **celandine** is from **chelidon**, the Greek word for a swallow. It was called the swallow flower, because it was supposed to come and go with the swallow. But this is not true. |

### WOOD ANEMONE OR WINDFLOWER

| | | | | |
|---|---|---|---|---|
| Woods and hedgerows. | March, April, and May. | A perennial plant, with a creeping rootstock, and deeply serrated leaves, arranged in threes along the stem. This plant has the bitter burning taste of the buttercup family. | It bears a single delicate white flower at the summit of the flower-stalk. The flower consists of sepals only (five to nine in number). There are no petals.<br>The flowers close towards evening and in wet weather.<br>Fruit, a small horned nut. | It is named the **windflower**, because the flowers are said to open in breezy weather. |

### LADY'S SMOCK

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Damp meadows and pastures. | April and May. | A perennial plant, with erect branching stems from 12 to 18 inches high, and compound pinnate (feather-shaped) leaves. | The small purplish-pink, or lilac flowers, have four sepals, and four petals, and the seed-vessel is a pod. | In many parts of the country this is known as the cuckoo-flower; but in some localities this name is given to other flowers. |

### LESSER PERIWINKLE

| | | | | |
|---|---|---|---|---|
| Woods, thickets, and hedgebanks. | Throughout the spring. | A perennial plant, with slender trailing stems, and small glossy leaves in pairs. | The flowers are sometimes white, but mostly lilac, and spring singly from the axils of the leaf-stalks. The calyx consists of five narrow sepals; the corolla has five petals.<br>The seed-vessel is a double capsule. | There is another variety of this plant known as the **larger periwinkle**, similar in all respects, but much larger. |

### RAGGED ROBIN

| | | | | |
|---|---|---|---|---|
| Damp meadows and the banks of streams and ditches. | May and June. | A perennial plant, with erect slender stems and small lance-shaped leaves. | A striking pink flower. The calyx is a sort of tube formed of five reddish-pink sepals. There are five spreading petals which have the appearance of a claw. | It takes its name of course from the ragged, spreading nature of the petals. |

### WOOD SORREL

| | | | | |
|---|---|---|---|---|
| Damp, shady spots in woodlands. | April and May. | An annual, with a creeping root-stock from which spring slender stalks. The leaf is compound, consisting of three heart-shaped leaflets. The upper side of the leaf is pale-green; the under side has a purplish tint. | The flowers are pure white, with purplish-pink veins. The corolla consists of five petals, the calyx of five sepals. The seed vessel is a capsule. | The leaves have a pleasant acid taste; they droop as night comes on, and in wet weather. Children often amuse themselves by pressing the seed-vessels between the finger and thumb, and so shooting the seeds to a great distance. |

## Common Vetch

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Open woodlands, dry pastures and waste lands. It is also cultivated in the farmer's fields as a forage plant. | Throughout the spring and early summer. | An annual. One kind has a weak, straggling stem, another is erect. Both have compound leaves (six to ten leaflets) with a tendril at the extremity. | Pea-shaped or butterfly flowers spring singly or in pairs from the axils of the leaves. The seed-vessel is a pod. | It is also known as the Tare. Tares are cut green, and provide a favourite food for horses and cows. The ripened seeds provide food for poultry and pigeons. |

## Compare with Lady's Fingers

| | | | | |
|---|---|---|---|---|
| Dry banks. | June, July, and August. | A perennial plant, also known as the kidney-vetch. Its stem, unlike those of most of the family, is erect and sturdy. The leaf consists of several pairs of leaflets, but there is no terminal tendril for support. | Pea-shaped flowers, cream, yellow, or red, which hang in close clusters. Seed-vessel a pod. | This is also one of the vetch family. The leaflets have a supposed resemblance to fingers of the hand. Hence the name. |

## Compare also with Wood Vetch

| | | | | |
|---|---|---|---|---|
| Woods and thickets. | Throughout the summer. | A perennial, with slender stems and compound (pinnate) leaves (eight to ten pairs of leaflets), and a tendril at the extremity. | Large pea-shaped flowers, white with purplish veins. | The seed vessel is a pod, which is much broader than the pods of most of the pea family. |

## Compare also with Meadow Vetchling

| | | | | |
|---|---|---|---|---|
| A hedgerow plant. It has been badly named, as it is never found in meadows. | From the middle of May till the end of summer. | A perennial climbing plant, with slender stalks, long lance-shaped leaves, in pairs, and a tendril at extremity. | Large yellow pea-shaped flowers. Seed vessel a pod. | This is the wild relation of the everlasting pea, which is common in every cottage garden. |

## DANDELION

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Found in great profusion in waste ground and meadows. | Throughout the spring summer, and autumn. | A perennial plant, with a long, solid tap root, and long, deeply-notched leaves. The root, when broken or cut across, sends out a milky juice, which has a very bitter taste. The name dandelion comes from **dent-de-lion.** Dent meaning a tooth. Hence lion's tooth. The pointed lobes of the leaves are supposed to have some sort of resemblance to the four long, pointed teeth of the lion. | Composite golden-yellow flowers. Each flower-stalk springs directly from the root. The flower-head is at first ball-shaped, but as it ripens, it opens. It consists of an immense number of distinct flowers, closely packed on one head. They are the florets. *These should be examined separately under a magnifying glass, and compared with those of the daisy.* In the daisy the ray florets only are strap-shaped. All the florets of the dandelion are strap-shaped. | Each separate floret has its own seed-vessel, which is enclosed in the calyx, and is furnished with a tuft of silky hairs, which spring from the top. The hairs grow as the seeds ripen, and these tufted seeds are easily scattered by the wind. *Compare them with the thistledown.* |

## SHINING CRANE'S BILL

| | | | | |
|---|---|---|---|---|
| Rocky places, hedgerows, and old stone walls. | May to August. | An annual, with long stalks, and glossy five-lobed leaves. | Small pink flowers, the calyx is five cleft; corolla has five small pink petals; and there are ten stamens —five long and five short. | There are several species of the family, but in all of them the flower-stalk divides into two smaller stalks, and each bears a flower. The flowers are in pairs.<br>The name comes from the peculiar form of the seed-vessel, which curls upward as it ripens, something like the bill of a crane. |

## Compare with the STORK'S BILL

| | | | | |
|---|---|---|---|---|
| On waste lands and by the roadside. | June to September. | An annual, with erect hairy stems about a foot high, and large doubly-pinnate serrated leaves. | Small pink flowers, which grow in umbels at the summit of the stalk. Calyx = five sepals; corolla = five petals. | Named like the crane's bill from the peculiar form of the seed vessel, which is said to resemble the bill of a stork. |

### IVY-LEAVED TOADFLAX

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Rocky places, and old, damp, moss-grown walls. | May to October. | A small perennial plant, with long trailing stems and ivy-shaped leaves, which are thick, fleshy, and smooth—green above and purplish red on the under side. | Pretty lilac flower, with a bright yellow centre, and a peculiar spur. Calyx = five sepals; corolla = five petals. | Commonly known as the mother of thousands. |

### Compare with the COMMON TOADFLAX

| | | | | |
|---|---|---|---|---|
| A hedgerow plant. | July to October | A perennial plant, with an erect stem two feet high, and long narrow leaves. | The striking yellow flowers, which grow in thick clusters at the top of the stalk, resemble in shape the snap-dragon of the cottage garden. | This is sometimes called the **wild snap-dragon.** It is also known to children as **"butter and eggs,"** the pale yellow part of the flower representing the butter, the rich orange part the yolk of eggs. |

### TRAVELLER'S JOY

| | | | | |
|---|---|---|---|---|
| Hedgerows and woods. | June to September | A perennial climbing plant, with tough strong stems, as thick as a man's wrist, and large heart-shaped leaves. The plant climbs by means of its leaf-stalks, which wind round their support like tendrils. | White fragrant flowers, consisting of four, five, or six sepals, but no petals.<br>The seed-vessel is a sort of nut, with a long feathery tuft at the top. | Known as the **wild clematis,** and the **old man's beard.** The farmers call it **with-bind,** because they use the tough stems to fasten up hurdles, gates, etc. |

### HEDGE-STACHYS

| | | | | |
|---|---|---|---|---|
| Woods and shady hedge-banks. | June to August. | A perennial plant, with an erect hairy stem, from two to three feet high, and hairy heart-shaped leaves. | The flowers grow in a spike at the top of the stalk. They are lip-shaped flowers of a delicate crimson-purple colour, the lower lip beautifully marked with white.<br>They have a powerful and not very pleasant odour. | Known also as the **hedge wound-wort,** because the leaves were formerly much used for dressing wounds. Wort = an old word for plant. |

## AGRIMONY

| Locality. | Flowering-time. | Kind of Plant. | Nature of Flower. | |
|---|---|---|---|---|
| Waste lands and banks by the roadside. | June and July. | A perennial plant, with erect hairy branching stems, about two feet in height; compound pinnate leaves; the leaflets are serrated, rough and hairy. | The flowers are small and yellow, and grow in a spike at the top of the stem.<br>Calyx has five sepals; corolla five petals. | There are two varieties. The flowers of one have a rich delicate fragrance. |

## CORN-FLOWER

| | | | | |
|---|---|---|---|---|
| Corn-fields, hedgerows, and waste land. | July, August, and September. | A perennial plant, with tough upright stems about two feet high, and long narrow leaves. | The flowers are composite. The disc florets are small, purple, and close set. The ray florets are large and conspicuous, and of a brilliant blue colour. | This plant is locally known as the "corn blue - bottle," the "blue cap," the "blue bonnet." |

## RAGWORT

| | | | | |
|---|---|---|---|---|
| Meadows, waste lands, and roadsides. | July to September. | A perennial, with erect branching stems about three feet in height, and ragged looking leaves. Hence the name. | The flowers are composite, and grow in thick clusters at the summit of the stem. The disc and ray florets are both of a bright golden yellow. | As in other flowers of this kind, each floret has its own seed-vessel, which is tufted with a silky down. |

## Compare with WATER RAGWORT

| | | | | |
|---|---|---|---|---|
| Borders of ditches and watercourses, and in damp low-lying meadows. | Throughout the summer. | A perennial plant, with erect branching stems about two feet high, and deeply-cleft, ragged-looking, dark-green leaves. | The flowers are composite, and grow in large heads of bloom. The disc and ray florets are both bright yellow. | The seeds are tufted with down, and as they ripen the down turns grey, which gives the flower-head a somewhat fanciful resemblance to the hoary beard of an old man. |

## BETONY

| | | | | |
|---|---|---|---|---|
| Woodlands and hedge-banks. | June to September. | A perennial plant, with a tall, square, hairy stem, and long, oval, serrated, coarse, hairy leaves, growing in pairs. | The flowers are purplish-red, and lip-shaped, the upper lip erect.<br>The seed-vessel is a sort of nut. | The leaves and flowers have a very peculiar aroma, and a bitter taste. The root is extremely bitter. |

# A TYPICAL RURAL CALENDAR.

## EXTRACT FROM THE CIRCULAR ISSUED BY THE BOARD OF EDUCATION, 1901

"A LIST of expected events and phenomena connected with natural objects of the neighbourhood is written out at the beginning of each month, and fixed in a prominent position in the school. Introductory explanations are given, accompanied, where possible, by pictorial illustrations. The scholars are required to be on the look-out for the various items on the list, and to bring the wild flowers, leaves, and buds to school, and these are handed round for inspection. The blank spaces on the list are filled in as the various objects make their appearance."

It is, of course, impossible to frame a complete calendar to suit all districts. Each teacher must necessarily make his own. The following list for April is taken from the above Circular as typical of a south-western county.

APRIL

| | Date of Observation. | By whom made. | Place. |
|---|---|---|---|
| I. BIRDS. | | | |
| Swallows come | | | |
| Martins make their appearance | | | |
| Cuckoo is heard | | | |
| Titlark sings | | | |
| Swift appears | | | |
| White-throat appears | | | |
| Black-cap returns | | | |
| Water-wagtail returns | | | |
| II. INSECTS. | | | |
| Lady-bird appears | | | |
| Cabbage butterfly appears | | | |
| Brimstone butterfly appears | | | |

| | Local Name. | When brought? | By whom. | Where found. |
|---|---|---|---|---|
| **III. WILD FLOWERS.** | | | | |
| Dog Mercury . . . | | | | |
| Lady's-smock . . . | | | | |
| Early Purple Orchis . . | | | | |
| Wild Strawberry . . . | | | | |
| Wild Hyacinths . . . | | | | |
| Cuckoo Pint . . . | | | | |
| **IV. TREES AND SHRUBS.** | | | | |
| Ash-tree flowers . . . | | | | |
| Elm in leaf . . . . | | | | |
| Blackthorn flowers . . | | | | |
| Beech in leaf . . . | | | | |
| Larch in leaf . . . | | | | |
| Wild Cherry in flower . . | | | | |
| Apple-tree flowers . . | | | | |
| Sycamore flowers . . . | | | | |
| Pear-tree flowers . . . | | | | |
| Pink cones of larch appear . | | | | |
| Trembling poplar flowers . | | | | |
| Horse-chestnut in leaf . . | | | | |
| Plum-tree flowers . . | | | | |

THE END

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